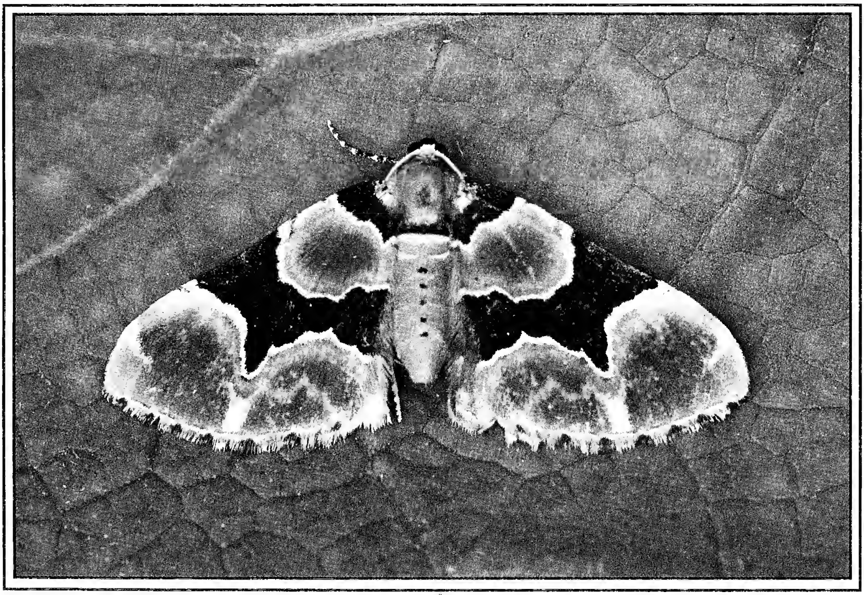
March 2007 ISSN 0952-7583 Vol. 20, Part 1

BRITISH JOURNAL OF ENTOMOLOGY AND NATURAL HISTORY



BRITISH ENTOMOLOGICAL & NATURAL HISTORY SOCIETY

BRITISH JOURNAL OF ENTOMOLOGY AND NATURAL HISTORY
Published by the British Entomological and Natural History Society and incorporating its Proceedings and Transactions

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British Journal of Entomology and Natural History is published by the British Entomological and Natural History Society, Dinton Pastures Country Park, Davis Street, Hurst, Reading, Berkshire RG10 0TH, UK. Tel: 01189-321402. The Journal is distributed free to BENHS members.

Typeset by Tavistock Digital Data, Tavistock, Devon.
Printed in England by Henry Ling Ltd, Dorchester, Dorset.

BRITISH ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY
Registered charity number: 213149

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SHORT-TERM CHANGES (2001–2005) IN GLOW-WORM *LAMPYRIS NOCTILUCA* L. (COLEOPTERA: LAMPYRIDAE) ABUNDANCE IN ESSEX

TIM GARDINER

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ABSTRACT

There is much anecdotal evidence to suggest that the UK Glow-worm *Lampyris noctiluca* population has declined in the last 50 years, but there has been little scientific research to confirm this. The Essex Glow-worm Survey commenced in 2001 with the aim of documenting changes in the abundance of glowing females using a standardised transect counting procedure. Results from the first five years of monitoring on 12 transects suggest that *L. noctiluca* is declining at six sites and increasing at only three. Indeed, glow-worms appear to have disappeared from one site where no females have been seen since 2001. Worryingly, the number of females seems to have declined significantly at two sites which had high abundance in 2001. One possible reason for these reductions may be low spring rainfall which may lead to desiccation of larvae and scarcity of larval food (snails and slugs) in the pre-pupation phase in dry and hot years such as 2003. It is hoped to continue the survey in future years to determine whether glow-worms are declining in the long-term.

INTRODUCTION

The Glow-worm *Lampyris noctiluca* L. (Coleoptera: Lampyridae) has a widespread but distinctly local distribution in Britain (Tyler, 2002), apparently being more abundant in southern England, especially on areas of chalk downland (Tyler, 1994). This species is predominantly a grassland insect, although it occurs in other habitats such as hedgerows and open woodlands (British Naturalist's Association, 1971). The status of *L. noctiluca* in Britain is poorly documented; however, some efforts have been made to ascertain its national distribution. The earliest of these was a survey conducted by the British Naturalists' Association (BNA) in the 1960s and early 1970s. It was from this initial survey that a decline in the British *L. noctiluca* population was first suspected; with many recorders noting an apparent fall in numbers (BNA 1971; 1974). In 1991/92, a survey was launched by Robin Scagell (Scagell, 2003), with the aim of both revisiting the sites identified by the BNA survey and investigating previously unrecorded ones.

However, much of the evidence for a decline in the British *L. noctiluca* population collected by the British Naturalists' Association and the UK Glow-worm survey is anecdotal (Scagell, 2003) and long-term studies on the abundance of glow-worms on individual sites are rare. In an attempt to scientifically document any decline in the abundance of this species in Essex, the Essex Glow-worm Survey was initiated in 2001 (Gardiner *et al.*, 2002). As part of this survey, members of the public were asked to establish a transect at a known colony and to monitor the abundance of glowing females, using a standardised method, for a number of years. The results of this study have already been used to determine the extent of colony isolation (Gardiner *et al.*, 2003a), the influence of soil pH on abundance (Gardiner *et al.*, 2003b), differences in density of glowing females between sites (Gardiner & Pye, 2004) and the effect of grazing and mowing on colony size (Gardiner & Gardiner, 2005). It is the aim of this

paper to present the results of these standardised counts after five years of monitoring and to assess any changes in abundance over this period.

Method

A transect was established at each of 12 sites with a known *L. noctiluca* colony to allow the abundance of glowing adult females to be ascertained, thus providing comparative data on population size at different sites. Habitats recorded at the transect sites included ancient woodland and unimproved meadow (Table 1). Several of these sites had legal conservation designations, with three transects on land designated as Sites of Special Scientific Interest (SSSI). The remaining transects were established on unprotected land in the general countryside, including rural roadside verges and scrubland.

Each transect was at least 100 m in length and was walked once in each of three two-week periods: 9–22 July, 23 July–5 August, and 6–19 August on an annual basis from 2001–2005. Any glowing adult females which were observed (e.g. that could be seen from the transect) along the route were recorded. It was felt that these three periods adequately incorporated the peak glowing season in Essex when most adult females would be displaying. The main disadvantage to using transect counts of glowing females as an estimation of colony size is that females only mate once, after which they stop glowing (Tyler, 2002). Therefore, low numbers of glowing females at a site may indicate successful breeding on previous nights rather than a small colony. Seven transects were walked in all five years, whereas, at five sites it was not possible to survey every year due to practical difficulties or the unavailability of suitable volunteers to walk the route.

Survey participants were required to commence each walk between 2200 and 2300 h, and to terminate by 0000 h. However, most walks were started at approximately 2200 h and had finished by 2300 h. Therefore, very few walks finished after 2330 h when females may have 'switched off' for the night. A slow strolling pace (0.7 km/h was the average searching/walking speed) was recommended for the walks

Table 1. Characteristics of the transect sites in Essex

Site name	Grid ref.	No. females counted	Description
Bulford Mill Lane	TL7720	64	Roadside verge with mature hedgerow
Danbury Woods	TL7806	70	Ancient woodland with rides and glades
Dry Street	TQ6986	26	Hedgerow with grassy path
Finches Nature Area	TQ9094	169	Scrub with rides and glades
Hadleigh Castle	TQ8186	89	Rough grassland and scrub around castle walls
Hatfield Forest	TL5420	20	Ancient grazed grassland adjoining ancient woodland
Iron Latch	TL9526	100	Restored meadow with fringing scrub and ancient woodland
Manwood Chase	TM0019	111	Meadow, scrub and woodland
Marks Hill	TQ6888	5	Hedgerow with grassy path
One Tree Hill	TQ7086	644	A mixture of meadow, scrub and woodland
Saffron Walden	TL5538	54	Area of amenity grassland in hospital grounds
Shut Heath Wood	TL8513	26	Ancient woodland with glades

to reduce the risk of overlooking glowing females along the route. Participants were asked not to conduct surveys in unfavourable conditions, for example, when it was cold, wet or windy, because counts may be reduced under such climatic extremes (Alexander, 1992). Inevitably some counts were undertaken when it was wet or cold.

Statistical analysis

The density of glowing females per 100 m was calculated for every walk conducted to allow a comparative measure of *L. noctiluca* abundance between sites with differing transect lengths. Counts of insects in grasslands can be very variable and many zero counts are often recorded and this influences the strategies appropriate for the analysis of data (Gardiner *et al.*, 2005b). In swards of variable structure it is safer to use distribution-free non-parametric statistics (Wilcoxon's paired samples test or similar) to avoid any misinterpretation of inferences drawn after analysis (Gardiner *et al.*, 2005b). Therefore due to the extremely heterogeneous vegetation structure of the sites (some were grazed and had extremely variable sward height), it was decided to use non-parametric statistics to analyse the data. The median density of females per 100 m/survey for 2001 and 2005 was compared at every site using Wilcoxon's paired samples test to determine any significant changes in abundance over the monitoring period. As there were only three surveys to compare in both years (e.g. only three replicates per site for each year), statistical significance was accepted at $P=0.10$. This approach has been used in other studies of insects such as Orthoptera where there was low replication (e.g. in Culm grasslands: Gardiner *et al.*, 2005a).

A relationship was suspected between spring rainfall and the abundance of females. To test this theory and ascertain whether rainfall influenced glow-worm density, Spearman's rank correlation was used to determine significant relationships between spring rainfall (total rainfall for March-May) and female abundance in each year for sites where female abundance was significantly different in 2001 and 2005 (e.g. where significant declines or increases were evident). Rainfall data were obtained from the Writtle College Weather Station (grid ref: TL678066) (Writtle College, 2004).

Results and discussion

The number of counts undertaken each year declined over the five years of the survey, although there were always >26 counts each year (Table 2). The highest count of females during the survey was 101 at One Tree Hill in 2002. Generally, most counts were very low (<10 individuals per survey). The highest overall densities (median of all counts at all sites) were in 2002 and 2005, with very low abundance of females (<1 female per 100 m) recorded at many sites in the very dry and hot 2003 (Table 2). However, comparisons between the overall abundance of *L. noctiluca* in different years, hides wide variations in female density between different years at individuals sites. *Lampyris noctiluca* appears to be declining at six sites and increasing at only three (Table 3). At Marks Hill, this species seems to have disappeared over the course of the monitoring period and was last seen in 2001. The number of females seen per night in the mid 1980s at this site was in excess of 50 (Mandy Greig, pers.comm.) so there may have been a long-term decline. The habitat at Marks Hill has remained superficially similar (e.g. hedgerow and mown verge habitat) for many years, therefore reasons for the decline and possible extinction remain unclear. Future monitoring should ascertain whether *L. noctiluca* has indeed become extinct at this site.

Table 2. Characteristics of the Essex *Lampyris noctiluca* survey

Characteristic	Year 2001	2002	2003	2004	2005
Median no. of females per 100 m/survey	1.78	1.83	0.95	1.00	2.00
Total no. of females	439	327	209	191	212
Maximum count	76	101	78	39	30
Total no. of counts	36	36	27	27	33
Climate					
Spring rainfall (March–May) mm	196.1	143.9	82.9	140.8	89.0

Worryingly, two of the colonies (One Tree Hill and Manwood Chase) with high female density in 2001 (>5 females per 100 m) have experienced significant reductions in abundance (Wilcoxon's value for both sites: -1.60, $P \leqslant 0.10$) over the monitoring period (Table 3).

Low spring rainfall (March–May; Table 2) may have led to reduced abundance of females at both sites in later years of the survey (particularly 2003 and 2005; Table 3). Indeed, there was a significant positive correlation between spring rainfall and the density of females in each year on both transects (r_s value for One Tree Hill: 0.82, $P<0.05$; r_s for Manwood Chase: 0.90, $P<0.05$). These results suggest that mature larvae in the pre-pupation phase in the spring months may have been unable to find sufficient snail prey to metamorphose into adults (which do not feed) later in the summer. Therefore, drought conditions in spring may lead to a scarcity of larval food (snails being more active in wet weather) and even desiccation of larvae in the pre-pupation phase in very dry and hot years such as 2003. There will of course be cumulative effects from drought conditions, for example, low numbers of females in 2003 will lead to fewer occurrences of mating and a low number of eggs being laid. This species has a two-year life cycle (e.g. larvae hatching in 2001 will become adult in 2003) and the low abundance of *L. noctiluca* in 2003 may have led to the low female density in 2005 (Table 3).

Soil conditions at the large colonies may have compounded the scarcity of snails in dry years. The soil at Manwood Chase is well drained (82% sand, unpublished data), whereas, at One Tree Hill, the transect was located on a south facing ridge where the well drained silt soil (74% silt, unpublished data) may increase larval scarcity in dry weather. Indeed, anecdotal evidence from One Tree Hill suggests that females have become increasingly restricted to damp hollows as the survey has progressed and may have a preference for the wetter north facing side of the ridge (Nick Stanley, pers.comm.). The importance of soil type seems to be confirmed by the lack of significant female declines at sites located on clay soils (e.g. Finches Nature Area, Iron Latch and Shut Heath Wood; Table 3) where water retention may be higher in dry years. However, data collected over a longer-time period is needed to determine the influence of soil type on glow-worm declines.

At Bulford Mill Lane there was a significant increase in female density over the five years (Wilcoxon's value: -1.60, $P \leqslant 0.10$). This site is a grassy roadside and the increase may reflect larvae spreading to uncolonised parts of the verge (Lin Wenlock, pers.comm.). The colony also connects with an active railway line which is known to support large glow-worm populations, which may be another source of migrating individuals. Such interconnected linear habitats may have a very important role to play in the future conservation of *L. noctiluca* in fragmented habitats (Gardiner & Tyler, 2002).

Table 3. Median number of females per 100m/survey at different transect sites with continuous (all years surveyed) and discontinuous (some years not surveyed) monitoring

Site	2001	2002	Year 2003	2004	2005	Status*	Sig**
Continuous monitoring							
One Tree Hill	5.6	4.0	3.6	3.6	1.5	–	$P \leqslant 0.10$
Manwood Chase	5.3	3.0	0.3	2.3	0.0	–	$P \leqslant 0.10$
Finches Nature Area	2.5	1.7	1.3	2.7	2.3	=	NS
Shut Heath Wood	1.0	2.0	1.0	0.0	2.0	=	NS
Danbury Woods	0.6	0.1	0.0	0.1	0.1	–	NS
Iron Latch	0.4	2.4	3.6	2.0	2.8	+	NS
Hatfield Forest	<0.1	<0.1	0.0	<0.1	<0.1	=	NS
Discontinuous monitoring							
Hadleigh Castle	5.9	5.5	NC	NC	3.0	–	NS
Saffron Walden	2.9	3.3	1.0	NC	0.5	–	NS
Marks Hill	2.0	0.0	NC	0.0	0.0	×	NS
Dry Street	1.0	2.0	NC	3.0	4.0	+	NS
Bulford Mill Lane	1.0	0.3	2.7	NC	3.7	+	$P \leqslant 0.10$

NC = no counts in that year
*status codes: – declining, + increasing, = no change, × = declining possibly extinct
**statistical significance between median values for 2001 and 2005 at $P \leqslant 0.10$ is shown, no significance is indicated as NS.

Caution must be exerted as the survey has only run for five years and more long-term data are needed to confirm declines and increases in glow-worm abundance and the potentially important relationship between spring rainfall and female abundance. It is hoped to continue the survey indefinitely to try to provide this information.

To provide more valid data in future survey years, refinements are needed to the sampling method. It has become clear that the highest female counts are in the first walk period (9–22 July) with lower numbers seen in periods 2 (23 July–5 August) and 3 (6–19 August). This indicates that the survey is starting too late in the female season, which is confirmed by reports from recorders of high numbers in late June/ early July in 2005 (Mike Wright, pers.comm.). Therefore, an earlier survey period (25 June–8 July) will be tested in future years.

Other refinements to the survey criteria are necessary due to variation in female counts as a result of walk timing and weather conditions:

(i) Avoid surveying on cloudless nights (<33% cloud cover) with a full moon due to difficulty in detecting females (Gardiner, 2006a).

(ii) Only undertake counts in dry weather as female numbers appear to be much higher on nights with heavy rain or drizzle (Gardiner, 2006c).

(iii) Start surveys between 2200–2230 h in periods 2 and 3 (23 July–19 August) as counts are very low after 2230 h in late summer (Gardiner, 2006b).

Acknowledgements

The author would like to thank all survey participants who walked transects at the different sites and to Essex Wildlife Trust for allowing surveys on their nature reserves. My gratitude is also extended to Writtle College for providing finance and resources for the duration of the survey.

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SHORT COMMUNICATION

More records of *Iassus scutellaris* (Fieber) (Hemiptera: Cicadellidae) in southern England. – Alex Ramsay's recent note (Ramsay, 2006) prompted me to unearth some recent records of this attractive hopper, including Berkshire records which predate his from Reading. I first took it in Berkshire at Cow Common (SU4392) (modern Oxfordshire), on 23.vii.1998. It was also locally abundant on elm hedges in the lower Kennet valley close to Reading around Sheffield Bottom and Theale Lake (SU6469), and Burghfield Mill (SU6770) in vii–ix.2004. In Surrey it seems to be present on most of the good stands of elm that I have sampled (e.g. Hatchlands (TQ0651) 25.vii.2001, West End Esher Common (TQ1262) vi.2004, Effingham (TQ1057) 3.ix.2006). It would appear to be a quite mobile species as it occurs on quite isolated stands of elm, as on Canvey Island, South Essex (TQ7782), vii–ix.2006. In my experience the bulk of adults are all bright green, but specimens with a dark thorax are not uncommon and look very like the commoner *Iassus lanio*, which is a problem in hedgerows with oak and elm mixed together. – Dr. JONTY DENTON, 29 Yarnhams Close, Four Marks, Hants, GU34 5DH.

Reference

Ramsay, A.J. 2006. *Iassus scutellaris* (Fieber) (Hemiptera: Auchenorrhyncha) new to Berkshire. *British Journal of Entomology & Natural History* **19**: 238.

LEPIDOPTERA IN SLOVENIA: A LEPIDOPTERIST'S ACCOUNT OF THE SOCIETY'S FIELD EXPEDITION TO SLOVENIA IN 2003

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INTRODUCTION

The seeds were sown by Mike Wilson, President 2004 – Head of Entomology, National Museums & Galleries of Wales, Cardiff when he attended the European Hemiptera meeting held in 2001 on the Adriatic coast of Slovenia.

The idea was seen as a possible initiative between the British Entomological & Natural History Society and the Slovenian Entomological Society and a link between National Museums & Galleries of Wales and The Slovenian Museum of Natural History, Ljubljana.

In Autumn 2001 a general invitation was extended to BENHS members via an advertisement included in the Society's Journal (Vol 14, Part 4, December 2001) with a request to register interest.

Unfortunately it transpired that the time scale for any firm commitments for 2002 proved too onerous and those that had expressed an interest were contacted with a view to signing up for a possible expedition to Slovenia in 2003 (see Figs 1 & 2).

In the event, 10 people from the UK covering a range of interests including Aculeate Hymenoptera, Diptera, Orthoptera, Coleoptera, Hemiptera and last but by

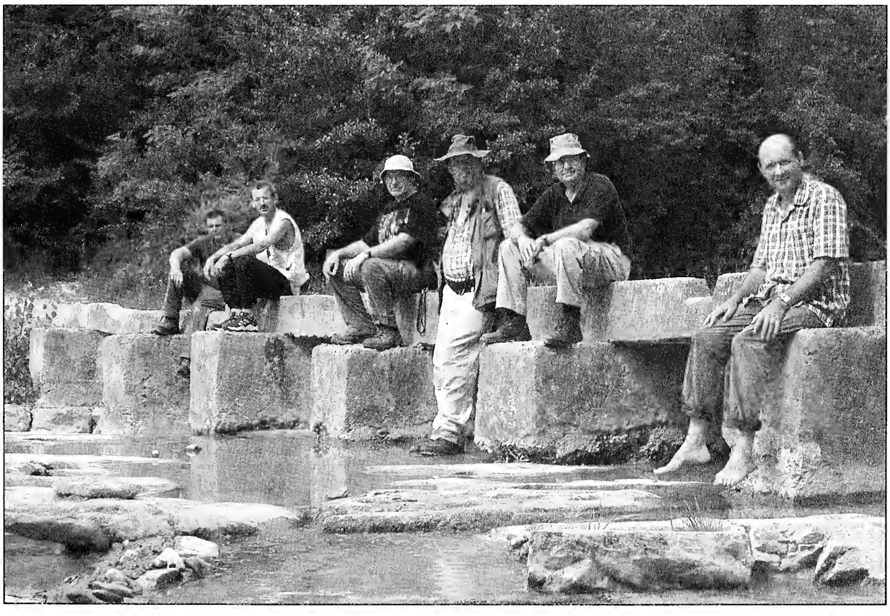

Fig. 1. Members of the expedition having a rest at Škrline, near the river Dragonja (210-A1, 80m), 8 June 2003. Left to right: Mark Pavett, Bogdan Horvat, Tony Pickles, Darwyn Sumner, John Phillips and Mike Wilson.

Fig. 2. Map of Slovenia.

no means least Lepidoptera committed themselves for 2003 and dates were set to visit Slovenia between 1st and 12th June 2003. The expedition members were Darwyn Sumner, Mark Pavett, Malcolm Smart, Mike Wilson, Peter Hodge, Mike Edwards, David Slade and Ralph Hobbs together with the authors (Fig. 1).

Whilst most participants could travel light and thus fly, an interest in Lepidoptera does not allow for such luxury, consequently the authors were forced to set off a few days early in advance by road carrying generators, light-traps, and other heavy equipment.

Our base for the stay was the Hudičevec Tourist Farm at Razdrto close to Postojna (Fig. 3), south west of the capital Ljubljana; which basically consists of suites of accommodation with a restaurant and of course, essentially, a bar attached to a working farm (Fig. 4).

The area rests at the foothills of the Nanos range of mountains in the south-west of the country very close to the Gulf of Trieste, north of Croatia and within striking distance of Italy and Venice.

Accommodation was kindly arranged via our hosts, the Entomology Department of the Slovenian Museum of Natural History and it was from here that department staff with several cars collected and conveyed us to various predetermined localities of different types, some days in the mountains, some near the coast, thereby giving us a taste of the variety of habitats on offer in their wonderful country.

In the limited time available it was only possible to visit a brief selection of sites selected by the museum, some of which suited the lepidopterists, others were more

Fig. 3. Hudičevec Tourist Farm.

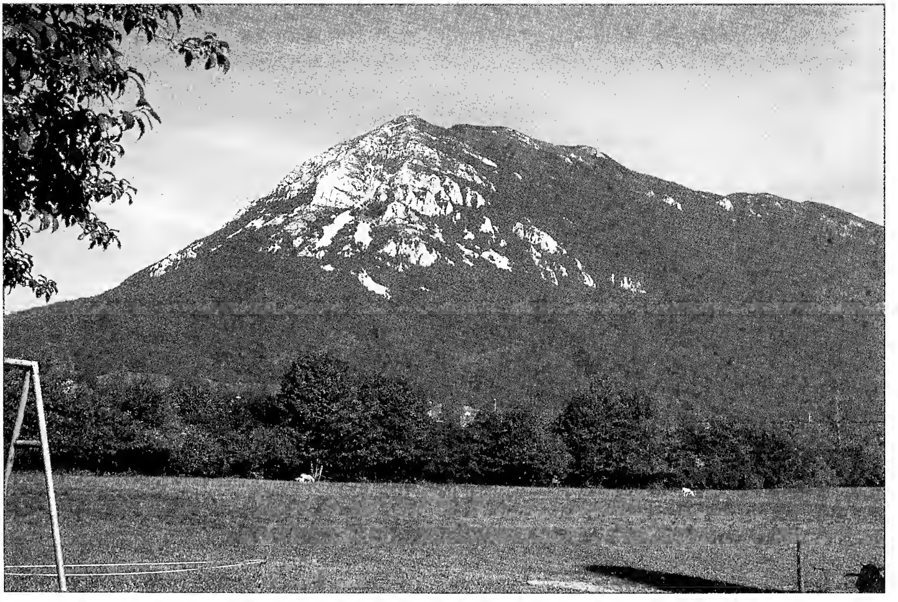

Fig. 4. Nanos Range – View from the Bar.

productive for the other Orders; however virtually everywhere one came across wonderful flower-rich meadows currently untouched by the EU Common Agricultural Policy where butterflies and other invertebrates abounded, although even now signs of development including road building were evident. The exact locations of the sites **A–M** visited are given in Appendix I.

Whilst to date land use has been mostly low-intensity farming with unimproved meadows cut for hay or grazed in the mountains which support an abundance of wild flowers; as the population becomes more urbanised the steeper meadows are being left uncut and encroaching scrub and woodland are gradually engulfing the countryside with inevitable loss of suitable habitat.

History of Slovenia

Slovenia was originally one of the old Balkan states and is situated at the northernmost end of the Adriatic, at the eastern end of the Alps where it borders Austria to the north, Hungary to the east, Croatia to the south and Italy to the west, with a short Adriatic coastline between Italy and Croatia.

Formally part of the Yugoslavian Federation it has been fully independent since 1991 and joined the European Union in 2004.

Landscape Regions

Slovenia can be divided into four basic landscape regions, namely Alpine and Sub-Alpine, Plains of the north-east, Karst Hills and Grasslands, and Coastal Mediterranean (Fig. 2).

A significant proportion of Slovenia is hilly, the two main river systems being the Sava, upon which the capital Ljubljana is situated and further, east the Drava. The principal mountain range to the north-west bordering Italy is the Julian Alps with the Kamnik Alps to the north bordering Austria.

The main geology is limestone with a rich grassland and alpine flora.

Beech and fir trees predominate in the hills but mixed deciduous woodland including oaks can be found in or near the river valleys.

In the meadows the grass is cut up to three times a year according to the prevailing weather conditions; after the cut the Lepidoptera tend to disappear, but soon return after two or three weeks.

Expedition Analysis and Notes

30 & 31 May 2003 – Having previously loaded the bulk of our equipment into the camper van we departed Hampshire at about 08.30h proceeding via Dover to Dunkirk, the ferry arriving about 15.30h local time, then via Calais and the auto-routes through eastern France and into Germany.

An early start on the second day via Germany and Austria saw us arriving in the Bled area north of Ljubljana late that evening; a total journey of about 900 miles.

1 June 2003 – Proceeding via Ljubljana we journeyed south-west down to the Postojna area, and quickly located our base, the Tourist Farm at Hudičevec.

As we were too early and the main body of the party was not flying in until late that evening we took the opportunity to explore the local area a little, taking the road west to Vipava via Razdrto to near Otosce – **Site A.**

In perfect humid hot and overcast conditions we stopped at a lay-by on this road where we came across a beautiful patch of grassland covering a hillside interspersed with scrub oak and other trees literally teeming with fritillary butterflies, day-flying moths and other invertebrates, a truly amazing and stimulating sight.

Fig. 5. Cerkinsko Jezero Lake.

We were to return to this site quite a few times during our stay in order to carry out further daytime survey work and to conduct some MV trapping at night.

Late afternoon saw us back at Hudičevec to await the remainder of the group.

2 June 2003 – Met the other members over breakfast who had flown in over night and had been brought to the farm by Museum staff.

As our hosts, the Slovenian Museum of Natural History were not arriving until the following day we decided to convey some of the group up to our site of the previous day near Otosce – **Site A.**

This proved just as productive as the day before with equally good weather conditions prevailing, in fact over the period this site proved the most productive for Lepidoptera with 102 species recorded including ten species of zygaenids, the beautiful rare geometer *Idaea aureolaria* (D. & S.) which abounded on the *Genista*, the arctiid *Spiris striata* (L.) which seemed to fly up at every step and the interesting saturnid, *Perisomena caecigena* (Kupido) which we found as larvae on scrub oak.

3 June 2003 – Joined by our hosts, the staff of Slovenian Museum Entomology Department with transport led by Dr Tomi Trilar and taken to two sites during the day.

Our first stop was at Volčje Blošco Jezero – **Site B**, east of Postojna, a high alpine meadow surrounding a small lake with numerous butterflies and moths, including *Erebia medusa* (D. & S.), *Carterocephalus palaemon* (Pallas), *Iphiclides podalarius* (L.), *Euphydryas aurinia* (Rott) and *Melitaea cinxia* (L.).

Amongst the moths it was nice to come across *Scopula immorata* (L), (Lewes Wave), this species having long since disappeared from the UK fauna.

On our way back we briefly stopped off at Rakov Škocjan – **Site C**, a wooded stream margin with a few butterflies where *Leptidea sinapis/reali* (L.) and *Cyanaris semiargus* (Rott) were flying.

4 June 2003 – This trip was firstly to one of the great sights and natural attractions in this part of Slovenia, the Cerknisko Jezero lake area south of Cerknica, stopping near Gorenje Jezero at the south-eastern end of the lake – **Site D** (Fig. 5). This is a vast expanse of wetland which has a unique geological feature in as much as the area is fed by underground streams which over the year floods in spring and then empties over the following months leaving the area dry.

These conditions provide a wonderful habitat for birds but proved somewhat disappointing for Lepidoptera during our relatively short stay. However we were treated to the spectacle of a pair of White-tailed Eagles *Haliaetus albicilla* L. making their daily journey to catch fish marooned in the rapidly drying river beds.

We then visited a unique attraction where a model of the lake demonstrates the annual cycle for the education of visitors.

Our next stop was at Otok Otoski Gric – **Site E** – on the southern shore of the lake, an area of uncut meadows amongst woodland, again only a few species were encountered.

However an evenings MV trapping in good conditions back at **Site A** proved most productive with *Phyllodesmia tremulifolia* (Hb), *Idia calvaria* (D. & S.), *Minucia lunaris* (D. & S.) and *Catephia alchymista* (D. & S.), coming to light amongst others.

5 June 2003 – JWP decided to stay at base for the day to catch up with a back-log of recording which proved to be a mistake as AJP with the remainder of the party were taken to some high alpine sites in the area just north of Ajdovscina.

Three stops were made at Čaven Malagora (1235 m) – **Site F,** Sinjivrh Rob (841 m) – **Site G** – and Podkraj (833 m) – **Site H;** butterflies and moths abounded with *Parnassus apollo* (L.), *P mnemosyne* (L.), *Iphiolides podalarius* (L.), *Papilio machaon* (L.), *Hemaris tityus* (L.), *Macroglossom stellatarum* (L.) and *Zygaena vicia* (D. & S.), being worthy of note. The *Z. viciae* on this site had a cingulum unlike our subspecies and this initially confused AJP.

6 June 2003 – Our hosts were away attending a lecture by Mike Wilson in Ljubijana, so a return was made to **Site A** by some of our party where similar species to previous days were on the wing.

In the evening MV lights were run in the woodland adjacent to the tourist farm but despite reasonable conditions very little of note came to light.

7 June 2003 – This day our scene of operations was an area nearer the coast adjacent to the border with Italy to Pliskovica Ledina/Marenca **Site I** – a very dry and hot typical karst grassland area with scrub which included an interesting cave system complete with bats (Fig. 6).

Species of Lepidoptera were in reasonable numbers including the beautiful geometer *Schistostege decussata* (D. & S.), which was abundant in one small grove of bushes; here the moths were sitting on grass stems looking like mini zebras with their black and white striped wings. Pale yellowish larvae of a species clearly akin to our *Lycia* were at rest amongst the rapidly drying grass and these proved to be *Lycia florentina* (Stef), when bred through.

Our second stop was a holiday home with an organic small holding situated in a perfectly beautiful valley with flower meadows, bordered on both sides by woodland at Brje Doli **Site J** (Fig. 7).

Our host, the owner, Professor Matija Gogala, a retired senior member of the Slovenian Natural History Museum very kindly provided food and copious quantities of local wine and it was somewhat difficult to tear ourselves away net in hand in order to sample the Lepidoptera on offer.

The shear profusion of insects in this relatively small area was amazing and included *Colias alfacariensis* (Ribba), *Zygaena purpuralis* (Brunnich), *Z. carniolica*

Fig. 6. Pliskovica Ledina/Marenca – Karst Grassland.

Fig. 7. Brje Doli – Valley with Flower Meadows.

Fig. 8. Škrline – River Dragonje.

(Scop), *Z. loti* (D. & S.), *Z. viciae* (D. & S.), *Argynnis niobe* (L.), *Limentis reducta* (Staud), *Iphiclides podalarius* (L.), *Leptidea sinapis/reali* (L.), *Pontia daplidice* (L.), together with *Heteropterus morpheus* (Pallas), to name but a few. The smallest European Wave, *Emmiltis pygmaearia* (Hb), was also encountered here. The site was a limestone outcrop and we were told it was probably the hottest area in Slovenia.

8 June 2003 – This was our last full day which started with a visit to Dragonja Križišče **Site K** – in the extreme south-west on the border with Croatia, comprising mixed farmland and a vine growing area next to some interesting scrubland.

Species encountered included *Jordanita globularia* (Hb), *Everes argiades* (Pallas), *Zygaena carniolica* (Scop.), *Brenthis daphne* (D. & S.), *Idaea ochrata* (Scop.), and *Emmelia trabealis* (Scop.). This was the only site where we saw the big satyrid, *Brintesia circe* (Fabr.), which we found had the habit of patrolling a fixed route and of returning to a favoured roost. AJP was lucky enough to encounter a female *Amata phegea* (L.), to which a male assembled while it was being photographed. A specimen of *Dysauxes famula* (Freyer), was also found at rest. Our second port of call was at Škrline on the River Dragonje **Site L** (Fig. 8) – a well known tourist spot, with scrub and woodland bordering its banks interspersed with smaller open areas.

Conditions were perfect with Lepidoptera in good numbers notable of which were *Nymphalis polychloros* (L.), *Heteropterus morpheus* (Pallas), *Libythea celtis* (Laicharting), sitting on the rocks by the river and also *Coenonympha oedippus* (Fabr.), a rare species currently considered endangered in Europe.

Pyropteron chrysidiformis (Esp.) was seen here as was the spectacular tiger moth *Rhyparia purpurata* (L.), of which we had also found as a larva earlier in the day.

Hudičevec Farm, Razdrto
1–8 June 2003

Throughout our stay a Robinson MV trap was operated adjacent to the farm buildings and we ran portable traps in adjoining woodland, on a couple of occasions, local daytime walks also revealed some interesting species.

Moths recorded included *Dendrolinus pini* (L.), *Trisateles emortualis* (D. & S.), *Sabra harpagula* (Esp.), *Siona lineata* (Scop.), *Minucia lunaris* (D. & S.) and *Trachea atriplicis* (L.). The moths recorded in the woods were reminiscent of our southern woodland but in much higher numbers.

The local dung heap attracted *Aptura iris* (L.) and *A. illia* (D. & S.), whilst *Lycaena virgaureae* (L.), was sighted in adjacent wet areas.

The other members of the party also seemed to find the area productive with salamander *Salamandra salamandra* (L.) (Caudata: Salamandridae) and fire bellied toads *Bombina variegata* (L.) (Anura: Discoglossidae) in the stream, field crickets were plentiful in the meadows and mole crickets *Gryllotalpa gryllotalpa* s.l. were heard at night, although not seen while we were there evidence of their underground feeding was found amongst fields of young bean plants and in the dung heap.

9–11 June 2003

Sadly the authors had to leave on 9th June to make the long journey back, although managing to fit in a night's trapping in central France at Bois de Merle near Verdan, but that's another story. A full list of the species of Lepidoptera recorded during our visit is given in Appendix II.

For the remaining members the visit ended with a tour of the famous Postoijna caves with sight of the white, blind cave-adapted amphibian, *Proteus anguinus* Laurenti (Caudata: Proteidae) which occurs in many of the limestone cave systems of Slovenia and Croatia.

Also to round off the trip a chance to visit the Slovenian Natural History Museum in the centre of Ljubljana where the insect collections stored off site were available for inspection.

Conclusions

For the lepidopterist, this small country is fascinating; its range of habitats is truly impressive, varying as it does between high-alpine, dry karst grassland, to coastal Mediterranean. A total of 183 species of butterfly are known from Slovenia (Celik & Rebeusek, 1996), which is about half the European fauna, remarkable for a country about the same size as Wales. During our week's stay we were fortunate to record 61 species of butterfly and 149 species of micro and macro-moths. For more information the reader is directed and recommended to read "Butterflies in Slovenia" by David Witherington (2003). Other information we have had access to is cited in the references.

Slovenia's geographical position giving easy access to Italy, Austria, Hungary and Croatia makes it an ideal holiday destination, the current authors cannot recommend it too highly, even for non-entomologists.

One sobering observation concerns the increasing urbanisation of the population and evidence of EU financing of road building and farm improvements, which over time will place increasing pressure on suitable wildlife habitats and thus its fauna and flora.

In the short time available we only scratched the surface of what is to be found, hopefully the Society will be invited back for more.

ACKNOWLEDGEMENTS

Firstly, the authors must thank our hosts and specifically Dr Tomi Trilar and his colleagues in the Entomology Department at The Slovenian Museum of Natural History, Ljubljana for their generous hospitality and finding the time to show us a part of their wonderful country, it was truly appreciated and without their support we would not have been able to find and visit the range of varied habitats we did. We must also thank Dr Mike Wilson for organising the trip and our colleagues with other specialities for insights into the various Orders they study. We also extend our thanks to Barry Goater for help with some identification.

Other Orders

Whilst this paper covers the outline of the expedition generally and the macro-Lepidoptera in particular, reference can in addition currently be made to the 2003 BENHS Annual Exhibition Report – *The British Journal of Entomology and Natural History* Vol 17 Part 3 as follows:

Slade D. Foreign Micro-Lepidoptera. Page 167.

Pavett P. M. Coleoptera, Cerambycidae. Page 177.

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APPENDIX I

Sites A–M visited

A: Otošče 14.03442E 45.76494N 486m 1,2,4,6.vi.2003
B: Volčje Blošco Jezero 14.52025E 45.78562N 745m 3.vi.2003
C: Rakov Škocjan 14.30487E 45.78984N 506m 3.vi.2003
D: Gorenje Jezero 14.40983E 45.72602N 553m 4.vi.2003
E: Otoski gric 14.37734E 45.74117N 523m 4.vi.2003
F: Čaven Malagora 13.85609E 45.92969N 1235m 5.vi.2003
G: Sinjivrh Rob 13.86530E 45.95562N 841m 5.vi.2003
H: Podkraj 14.06759E 45.86472N 833m 5.vi.2003
I: Pliskovica Marenca 13.78874E 45.78026N 250m 7.vi.2003
J: Brje Doli 13.73087E 45.78896N 216m 7.vi.2003
K: Dragonja Križišče 13.66736E 45.45316N 28m 8.vi.2003
L: Škrline R. Dragonje 13.76049E 45.46975N 78m 8.vi.2003
M: Razdrto Hudičevec 14.08721E 45.75515N 545m 1-8.vi.2003

APPENDIX II

Systematic list of Lepidoptera recorded in Slovenia 1–8 June 2003

Tineidae
724 *Euplocamus anthracinalis* (Scop.) M

Limacodidae
3907 *Apoda limacodes* (Hufn.) A, M

Zygaenidae
3943 *Jordanita globulariae* (Hb.) A, K
3956 *Adscita statices* (L.) A, K
3974 *Zygaena purpuralis* (Brünnich) A, J
3980 *Zygaena carniolica* (Scop.) A, J, K
3983 *Zygaena loti* (D. & S.) A, G, J
3991 *Zygaena osterodensis* Reiss A
3992 *Zygaena viciae* (D. & S.) *ssp. stenzii* Freyer A, G
3996 *Zygaena transalpina* (Esp.) A
3998 *Zygaena filipendulae* (L.) A
3999 *Zygaena lonicerae* (Scheven) A, B

Sesiidae
4090 *Pyropteron chrysidiformis* (Esp.) L

Thyridoidea
5562 *Thyris fenestrella* (Scop.) E, J, K

Pyralidae
5679 *Elegia similella* (Zinck.) A
5751 *Oncocera semirubella* (Scop) A, L
5807 *Hypochalcia fuliginella* (Dup.) M
5810 *Hypochalcia lignella* (Hb.) I
6163 *Scoparia manifestella* (H-Sch.) A
6172 *Scoparia pyralella* (D. & S.) A
6251 *Crambus lathoniellus* (Zinck.) A
6283 *Catoptria osthelderi* (Lat.) A
6284 *Catoptria speculalis* (Hb.) E, L
6350 *Thisanotia chrysonuchella* (Scop.) L
6394 *Donacaula mucronella* (D. & S.) M
6446 *Cynaeda dentalis* (D. & S.) L
6478 *Eurrhypis pollinalis* (D. & S.) I
6588 *Ecpyrrhorrhoe rubiginalis* (Hb.) A
6605 *Pyrausta purpuralis* (L.) A
6624 *Sitochroa verticalis* (L.) A
6655 *Anania verbascalis* (D. & S.) A
6672 *Mecyna flavalis* (D. & S.) A
6680 *Agroptera nemoralis* (Scop.) A, J

Lasiocampidae
6744 *Malacosoma castrensis* (L.) M
6749 *Lasiocampa trifolii* (D. & S.) A (larva)
6755 *Macrothylacia rubi* (L.) M
6763 *Dendrolinus pini* (L.) A, M
6773 *Phyllodesmia tremulifolia* (Hb.) A, M
6780 *Odonestis pruni* (L.) A, M

Saturniidae
6794 *Saturnia pavonia* (L.) A (larva)
6797 *Perisomena caecigena* (Kupido) A (larva)

Sphingidae
6819 *Mimas tiliae* (L.) M
6823 *Laothoe populi* (L.) M
6839 *Hemaris tityus* (L.) F
6843 *Macroglossum stellatarum* (L.) F, L, M

Hesperidae
6879 *Erynnis tages* (L.) A
6904 *Pyrgus malvae* (L.) K, L
6906 *Pyrgus serratulae* (Ramb.) J, L
6917 *Heteropterus morpheus* (Pallas) J, K, L
6919 *Carterocephalus palaemon* (Pallas) B
6930 *Oclodes venata* (Brem. & Grey) B

Papilionidae
6947 *Allancastria cerisy* (Godart) H (larvae)
6953 *Parnassius mnemosyne* (L.) F, G
6955 *Parnassius apollo* (L.) G
6958 *Iphiclides podalirius* (L.) B, F, J (larvae)
6960 *Papilio machaon* (L.) A (larva), I

Pieridae
6966 *Leptidea sinapis* (L.) C, E, J, K
6993 *Aporia crataegi* (L.) B, E
6995 *Pieris brassicae* (L.) J
6998 *Pieris rapae* (L.) J

7005 *Pontia daplidice* (L.) J
7022 *Colias alfacariensis* (Ribbe) J
7024 *Gonepteryx rhamni* (L.) A

Lycaenidae
7030 *Hamearis lucina* (L.) B
7034 *Lycaena phlaeas* (L.) L
7037 *Lycaena virgaureae* (L.) M
7041 *Lycaena hippothoe* (L.) B, K
7065 *Satyrium ilicis* (Esp.) A, J, K
7088 *Cupido minimus* (Fuessly) B
7093 *Everes argiades* (Pallas) K
7094 *Everes decoloratus* (Staud.) K
7127 *Plebejus argus* (L.) K
7145 *Aricia agestis* (D. & S.) A, B
7152 *Cyanaris semiargus* (Rott.) A, C
7156 *Agrodiatus escheri* (Hb.) K
7163 *Polyommatus icarus* (Rott.) B, E
7172 *Meleageria bellargus* (Rott.) A, B, K

Nymphalidae
7199 *Libythea celtis* (Laicharting) L
7204 *Argynnis aglaja* (L.) A
7205 *Argynnis adippe* (D. & S.) A, F
7206 *Argynnis niobe* (L.) f. *eris* J
7213 *Brenthis ino* (Rott.) A
7214 *Brenthis daphne* (D. & S.) K
7215 *Brenthis hecate* (D. & S.) A
7228 *Clossiana dia* (L.) J
7258 *Nymphalis polychloros* (L.) L
7268 *Euphydryas aurinia* (Rott.) B
7270 *Melitaea cinxia* (L.) A, B
7271 *Melitaea phoebe* (D. & S.) C
7275 *Melitaea didyma* (Esp.) A, B, C
7280 *Melitaea aurelia* (Nickerl) A, B
7281 *Melitaea britomartis* (Assman) A, B
7283 *Melitaea athalia* (Rott.) A, B, E
7288 *Limenitis reducta* (Staud.) J
7298 *Apatura ilia* (D. & S.) M
7299 *Apatura iris* (L.) M

Satyridae
7307 *Pararge aegeria* (L.) M
7312 *Lasiommata maera* (L.) A, J
7315 *Lopinga achine* (Scop.) A
7322 *Coenonympha oedippus* (Fabr.) L
7325 *Coenonympha arcania* (L.) A, B, E, I, J, K, L
7334 *Coenonympha pamphilus* (L.) A, B, G, J, L
7350 *Maniola jurtina* (L.) B
7379 *Erebia medusa* (D. & S.) B
7415 *Melanargia galathea* (L.) A, E, I, J, K
7447 *Brintesia circe* (Fabr.) K

Drepanidae
7486 *Tethia or* (D. & S.) M
7510 *Sabra harpagula* (Esp.) A, M

Geometridae
7527 *Lomaspilis marginata* (L.) A
7537 *Helidmata glareria* (D. & S.) A
7547 *Chiasmia clathrata* (L.) A, M
7606 *Plagodis pulveraria* (L.) M
7607 *Plagodis dolabraria* (L.) M
7636 *Ennomos erosaria* (D. & S.) A
7677 *Lycia florentina* (Stef.) I (larvae)
7685 *Biston strataria* (Hufn.) A (larvae)
7686 *Biston betularia* (L.) A (larvae)
7783 *Hypomecis roboraria* (D. & S.) M
7796 *Ectropis crepuscularia* (D. & S.) M
7804 *Ematurga atomaria* (L.) A
7826 *Cabera exanthemata* (Scop.) B
7844 *Pungelaria capreolaria* (D. & S.) A, M
7916 *Siona lineata* (Scop.) M
7965 *Pseudoterpna pruinata* (Hufn.) A
8019 *Cyclophora porata* (L.) M
8024 *Cyclophora linearia* (Hb.) A, M
8036 *Scopula immorata* (L.) A, B
8043 *Scopula virgulata* (D. & S.) A
8099 *Idaea ochrata* (Scop.) K
8102 *Idaea aureolaria* (D. & S.) A
8104 *Idaea muricata* (Hufn.) A
8168 *Idaea pallidata* (D. & S.) A
8191 *Emmiltis pygmaearia* (Hb.) A, J
8225 *Cataclysme dissimilata* (Ramb.) A
8227 *Phibalapteryx virgata* (Hufn.) A
8232 *Scotopteryx coarctaria* (D. & S.) A
8269 *Catarhoe cuculata* (Hufn.) M
8275 *Epirrhoe alternata* (Mllr.) M
8277 *Epirrhoe rivata* (Hb.) M
8289 *Camptogramma bilineata* (L.) A, M
8391 *Hydriomena furcata* (Thunb.) M
8392 *Hydriomena impluviata* (D. & S.) M
8411 *Melanthia procellata* (D. & S.) M
8423 *Rheumaptera undulata* (L.) M
8428 *Triphosa dubitata* (L.) C (larvae)
8433 *Philereme transversata* (Hufn.) M
8463 *Perizoma albulata* (D. & S.) A
8512 *Eupithecia gratiosata* (H-Sch.) A

8603 *Rhinoprora rectangulata* (L.) A
8635 *Schistostege decussata* (D. & S.) I
8663 *Minoa murinata* (Scop.) A

Notodontidae
8704 *Cerura vinula* (L.) A (larva)
8721 *Drymonia dodonaea* (D. & S.) M
8739 *Ptilodon cucullina* (D. & S.) M
8750 *Phalera bucephala* (L.) A, M
8754 *Peridea anceps* (Goeze) f. *acerba* A (larva)
8758 *Stauropus fagi* (L.) A, M
8762 *Spatalia argentina* (D. & S.) A, M

Noctuidae
8780 *Acronicta megacephala* (D. & S.) M
8789 *Craniophora ligustri* (D. & S.) A
8835 *Idia calvaria* (D. & S.) A
8839 *Paracolax tristalis* (Fabr.) M
8845 *Herminia tarsicrinalis* (Knoch) A
8849 *Polypogon tentacularia* (L.) A, E, K, M
8852 *Polypogon strigilata* (L.) M
8897 *Minucia lunaris* (D. & S.) A, M
8956 *Catephia alchymista* (D. & S.) A
8969 *Euclidia glyphica* (L.) A
8975 *Laspeyria flexula* (D. & S.) A, M
9006 *Phytometra viridaria* (Clerck) L
9016 *Parascotia fuliginaria* (L.) M
9027 *Euchalcia variabilis* (Piller) M
9056 *Autographa gamma* (L.) A, M
9094 *Abrostola agnorista* (Dufay) M
9097 *Emmelia trabealis* (Scop.) K
9114 *Lithacodia pygarga* (Hufn.) A
9169 *Trisateles emortualis* (D. & S.) M
9199 *Cucullia umbratica* (L.) M
9396 *Elaphria venustula* (Hb.) A
9453 *Hoplodrina respersa* (D. & S.) A, M
9456 *Charanyca trigrammica* (Hufn.) M
9458 *Atypha pulmonaris* (Esp.) M
9483 *Rusina ferruginea* (Esp.) M
9501 *Trachea atriplicis* (L.) A, M
9515 *Actinotia polyodon* (Clerck) M
9748 *Apamea monoglypha* (Hufn.) M
9753 *Apamea sublustris* (Esp.) M
9755 *Apamea crenata* (Hufn.) M
9771 *Apamea sordens* (Hufn.) M
9874 *Chortodes extrema* (Hb.) M
9933 *Hadena bicruris* (Hufn.) M
9935 *Hadena luteago* (D. & S.) A, M
9946 *Hadena filigrama* (Esp.) A, G
9993 *Polia nebulosa* (Hufn.) H, M
10005 *Mythimna straminea* (Treitschke) M
10232 *Anaplectoides prasina* (D. & S.) A, M
10372 *Colocasia coryli* (L.) A, M

Lymantridae
10376 *Lymantria dispar* (L.) A (larva)

Nolidae
10422 *Meganola togatulalis* (Hb.) M
10423 *Meganola strigula* (D. & S.) M
10441 *Nycteola revayana* (Scop.) M

Arctiidae
10477 *Cybosia mesomella* (L.) A, I
10499 *Eilema sororcula* (Hufn.) A, M
10517 *Amata phegea* (L.) K
10522 *Dysauxes famula* (Freyer) K
10526 *Spiris striata* (L.) A, I
10572 *Diaphora mendica* (Clerck) M
10579 *Rhyparia purpurata* (L.) K(larvae)L
10583 *Diacrisia sannio* (L.) A, B ,E, I, J, L, M
10600 *Arctia villica* (L.) A

The sequence of species and reference numbers is based on Karsholt & Razowski (1996). Subspecific names follow the various publications listed in 'References'.

BOOK REVIEW

Bumblebees, the natural history & identification of the species found in Britain by Ted Benton. xi + 580 pp. 2006, The New Naturalist Library, Harper-Collins, London. Paperback ISBN 0-00-717451-9, £25.00.

Because they are common and colourful, big and fuzzy, bumblebees are among the most popular insects in Britain. This creates a substantial market for books on the subject. Perhaps in recognition of this, there have been more books on British bumblebees in the last seven years (9) than in the previous century (6). By far the largest of them, in terms of numbers of pages, is the new *New Naturalist* book by Ted Benton. This seeks to cover all aspects of bumblebee biology for a general naturalist reader.

Aside from the life cycle, Benton's *Bumblebees* concentrates most on the foraging behaviour, identification, and conservation of British bumblebees. There is an introduction, a chapter describing the life cycle, another on 'bumblebee psychology', others on the cuckoo bumblebees (subgenus *Psithyrus*), predators and parasites, two chapters on foraging behaviour, two on identifying and describing the British species, and two chapters on conservation issues. There are four appendices: on species extinct in Britain; useful addresses; names of plants; and books on bumblebees. These are followed by a bibliography and index.

As a *New Naturalist* book, this is not intended primarily for an academic audience and it does have a very relaxed writing style. In the foreword, Ted states that he wishes to give a sense of the dialogue between research traditions and to represent something of the process by which knowledge is acquired and assessed. He describes his approach as influenced by recent feminist and sociological approaches to understanding science. Describing the process by which knowledge develops is highly desirable, but it does add to the length, and in some cases it needs a tighter grasp of the origins and relationships of ideas. There are places where the book is only approximately correct on facts such as dates, so that while it gives the general picture across a very broad range of subjects, some may wish to check details with books such as Goulson's 2003 *Bumblebees*.

Inevitably this book will be compared with Free and Butler's 1959 book on *Bumblebees* in the *New Naturalist* series. It is tempting to wonder whether the greater emphasis on conservation issues in the new book and a greater interest in social structure in the earlier book reflect society's changing enthusiasms. Similarly, one of the most original books on bumblebees, Bernd Heinrich's 1979 *Bumblebee economics*, coincided with a growing emphasis on free market economics in the USA and Britain.

One of the greatest joys of this book is Ted's many excellent photographs of bumblebees (and of other insects). It feels like a monograph on bumblebee biology and is a little on the large side for an introduction to their natural history, or for use as a field guide for identification (cf. Edwards and Jenner's 2004 guide), but it does contain a great deal of information for dipping into and is very readable. It will be an essential for anyone with an interest in bumblebees.

P. H. WILLIAMS

Edwards, M. & Jenner, M. 2004. *Field guide to the bumblebees of Great Britain & Ireland.* Eastbourne: Ocelli. 108pp.

Free, J.B. & Butler, C.G. 1959. *Bumblebees.* London: Collins. xiv + 208pp.

Goulson, D. 2003. *Bumblebees, their behaviour and ecology.* Oxford: Oxford University Press. ix + 235pp.

Heinrich, B. 1979. *Bumblebee economics.* Cambridge: Harvard University Press. viii + 245pp.

BEES AND WASPS IN THE DIVERSIFIED CONIFEROUS WOODLAND SETTINGS OF BRITISH CENTERPARCS

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ABSTRACT

The potential value of diversified coniferous woodland settings for bees and wasps was revealed by a long-term study of four English Centerparc villages. These collectively produced a list of 259 species (over 50% of the mainland British list) including numerous rarities. Sampling at Elveden Centerparc in Suffolk produced a list of 203 confirmed species making it one of the richest sites for bees and wasps in Britain today. The quantity and diversity of open habitats within a coniferous setting, and their management, have a major bearing on the quality of the bee and wasp fauna. A checklist of management techniques to encourage a diverse bee and wasp fauna in coniferous settings is provided.

INTRODUCTION

Following the end of World War II, large expanses of heathland, moorland and broadleaved woodland (usually ancient) were planted up with serried rows of fast growing conifers in an effort to make Britain self-sufficient in timber. This planting programme resulted in some significant losses of valuable semi-natural habitat, particularly in areas such as Dorset, East Anglia, Nottinghamshire and some other heathland and moorland districts. Sadly, the quality of some of the timber was so poor that financial loss was incurred and there has been a degree of soul searching over certain schemes ever since. For many wildlife groups, including bees and wasps, there are relatively few opportunities in coniferous plantations other than within any rides, or the temporary clearings created by felling and replanting.

In recent years, the Forestry Commission (particularly its Forest Enterprise wing) has declared an intention to restore broadleaved woodland, heathland and other habitats of higher nature conservation and amenity value within areas of coniferous plantation (notably within Dorset and Breckland) as a contribution to the UK BAP targets for Priority Habitats such as Lowland Heathland (UK Government, 1994; UK Biodiversity Steering Group, 1995: Anon, 1998). Conifer removal to create heathland is also a target of several local biodiversity action plans, including those for Dorset, Hampshire and Suffolk.

But how does one go about converting a large, relatively impoverished conifer plantation into an ecologically diverse site supporting a range of habitats with a good range of flora and fauna that includes rare and unusual species? In 1994, the author was commissioned to survey aculeate Hymenoptera and Diptera at Elveden Centerparc, Suffolk. This was the start of an 11-year study that expanded to cover four coniferised Centerparc settings in widely separated parts of England. It has provided an ideal opportunity to answer the above question for bees and wasps within sites that still remain partially coniferised and are also subject to high levels of recreational activity.

Methods

Study Sites

There are currently four British Centerparcs, all within England:

1. Longleat Forest – located at the eastern end of the Longleat Forest-Longleat Park complex, Wiltshire (ST8342), in plantation woodland dominated by non-native conifers such as silver firs and redwoods. The ground mostly consists of compacted acidic sands and clays, though small patches of more calcareous soil are present. This is the hilliest Centerparc.
2. Elveden Forest, Suffolk (TL8080) (Fig. 1) – located within Thetford Forest, adjacent to Lakenheath Warren SSSI, and close to Wangford Warren which once supported inland mobile dunes. The plantation woodland is dominated by pines and ground conditions comprise mostly loose, chalky sands, producing some dry calcareous grassland, but also some more acidic areas with bracken and limited heathland.
3. Sherwood Forest, Nottinghamshire (SK6268) – as its name suggests is part of the larger Sherwood Forest complex and is dominated by pines on consistently acidic, sandy soils. There is also a small block of semi-natural broadleaved woodland along the entrance drive.
4. Whinfell Forest, Westmorland (NY5227) – formerly known as the 'Oasis', is located within a larger block of coniferous plantation (though less extensive and more isolated than the other sites) which is dominated by pines and features acidic soils that range from compacted sand to peat and loam.

Figure 1. A typical Centerparc residential landscape (Elveden), with villas arranged in clearings containing a pool and informally managed habitats such as grassland and scrub that can support good assemblages of ground-nesting and aerial-nesting aculeates.

The four villages are entirely, or mainly, located within land that was dense coniferous plantation prior to development. The landscaping that has taken place since follows a generally similar pattern featuring the following components:

(i) Coniferous woodland – the dominant habitat, sometimes featuring the original plantation woodland in a dense, unmodified state, but increasingly being thinned to promote a better ground flora.
(ii) Broadleaved woodland – best represented at Sherwood (semi-natural in character), but with some young plantation woodland at Elveden and small patches of secondary woodland at Longleat and Whinfell.
(iii) Villa and plaza landscapes – several hundred villas typically located within thinned coniferous woodland, and each typically arranged with its rear end facing pools or linear water features (except at Whinfell Forest which only has a boating lake); also a central plaza with restaurants and sport facilities. The villas tend to be located within informally managed areas with minimal mowing and naturalistic landscaping, whilst the plaza areas tend to have formal landscaping lacking semi-natural habitat.
(iv) Water features within clearings – includes a main boating lake, which may have some useful surrounding habitat (e.g. Longleat, Elveden, to a lesser extent Sherwood and scarcely at all at Whinfell), plus subsidiary lakes and linear water features running through the villa landscape (except Whinfell). The linear water features are located within larger clearings that typically feature emergent and marginal vegetation grading into grassland, heathland or tall herb, scrub and surrounding woodland. In some cases the grassland has been enhanced by artificial seed mixtures, though at Elveden the seed bank has also produced an impressive natural response involving some very rare native plants such as fingered speedwell *Veronica triphyllos* L. and white horehound *Marrubium vulgare* L.
(v) Wildflower meadows and other discrete grasslands – of varying quality, extent and character. Particularly impressive at Elveden due to the chalky sands that underlie the site, and parts of Longleat (Fig. 2).
(vi) Restored heathland – as all the plantations occur on sandy soils in districts that historically featured heathland, heathers have often established themselves naturally following woodland clearance. But special measures have been taken to promote the heathland at Longleat (Nockatt Coppice Nature Reserve) and Sherwood (compartment 45).
(vii) Car parks – the main car parks (excluding Longleat) feature scrub, fringes of grassland and sparsely-vegetated sand (Fig. 3). These can be very productive.
(viii) Banks, balancing pools and dumping areas – small areas often managed informally and often acquiring a very flowery character after a few years – most notably at Whinfell where such areas provide the only substantial areas of flower-rich habitat within the village.
(ix) Log piles – notably at Elveden and Whinfell, though often temporary in nature (Fig. 4).

The result is four sites that can be best described as 'diversified coniferous settings'.

Methodology

All the survey work was undertaken on a commercial basis, so the amount undertaken in a given year was dictated by contractual agreement. It typically involved two days worth of surveying of each site in a given year. Occasionally it

Figure 2. An example of a 'created' wildflower meadow (Longleat). With the right choice of plants and management, these can provide forage areas for many aculeates, especially where plants such as thistles, umbellifers and bird's-foot trefoils are present.

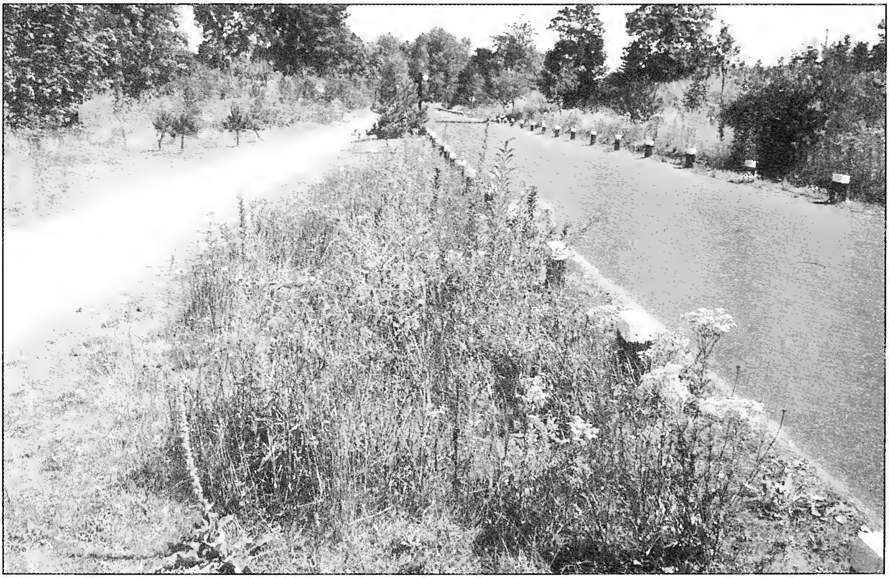

Figure 3. Many areas of a Centerparc village can be managed to encourage wildlife such as aculeates with the right management, including verges, car parks, golf courses and lakesides.

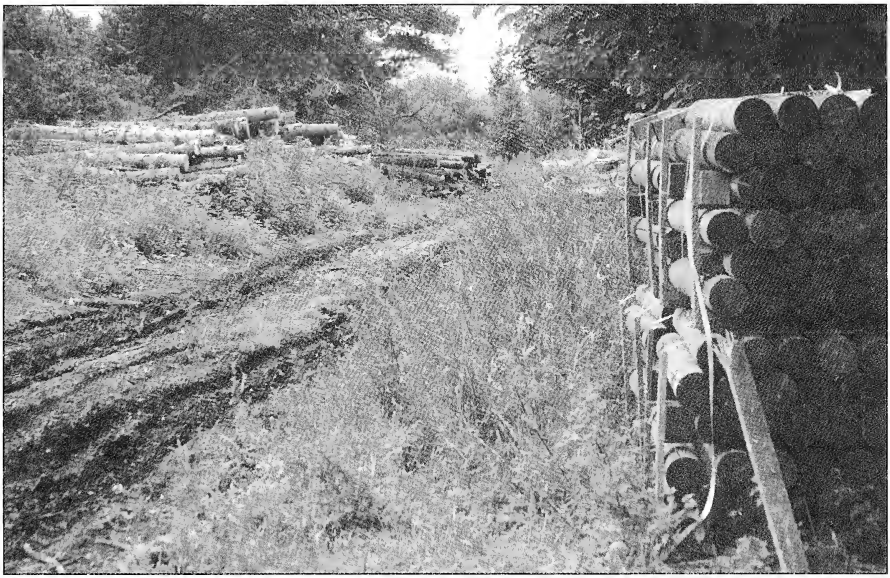

Figure 4. Logpiles at Elveden. These are vital for aerial nesting species and informal dumping and storage areas such as these can be very flowery.

would involve three, but if bad weather was encountered (and much effort was taken to avoid this), only a single day of proper surveying might be possible. Dates of visits were varied from year to year in order to capture data from April to August, and occasionally later. Elveden was surveyed from 1994–2004, Longleat and Sherwood from 1995–2004 and Whinfell Forest (a late addition to the Centerparc portfolio) from 2002–2004. Dates of visits (bracketed dates refer to visits during sub-optimal weather):

- Longleat: 30.iv.95, 12.viii.95, 2.vi.96, (28.vii.96), 19.vii.97, 20.vii.97, (13.vi.98), 5.vii.98, (9.x.99), (10.x.99), 6.vi.00, 8.vi.00, (20.vi.01), 21.vi.01, (1.vii.02), 2.vii.02, 18.vii.03, 19.vii.03, 20.vii.03, 25.vi.04, 27.vi.04.
- Elveden: 23.iv.94, 23.vii.94, 20.v.95, 6.viii.95, 23.vi.96, 17.viii.96, 21.vi.97, 22.vi.97, 11.vii.98, (12.vii.98), 27.v.99, 28.v.99, 24.v.00, (25.v.00), 6.vii.01, (8.vii.01), 17.v.02, 28.vii.02, 16.iv.03, 5.vii.03, 19.vii.04, 7.viii.04.
- Sherwood: (24.vi.95), 30.vii.95, (28.iv.96), 13.vii.96, 30.v.97, 1.vi.97, 29.viii.98, 13.ix.98, 26.vi.99, 18.vii.99, 6.v.00, 7.v.00, 3.vii.01, 4.vii.01, 5.vii.01, 20.v.02, 21.v.02, 13.iv.03, 29.vi.03, 18.vii.04, 21.viii.04.
- Whinfell: (15.vii.02), 16.vii.02, 13.vi.03, 14.vi.03, 15.vi.03, (28.v.04), 30.v.04.

Survey techniques included visual surveillance of foraging and nesting habitats and careful sweeping of different habitats with a long-handled insect net. Areas surveyed included patches of flowers, sparsely vegetated areas, dead wood in sunny locations and sunlit foliage. Special attention was given to the flowers that supported the biggest foraging assemblages at particular times of year, which included (depending on the site):

Spring: grey willow (sallow) *Salix cinerea*, blackthorn *Prunus spinosa*, wild cherry *Prunus avium*, hawthorn *Crataegus monogyna*, common gorse *Ulex europaeus*, dandelions *Taraxacum* spp., daisy *Bellis perennis*, coltsfoot *Tussilago farfara*, cow parsley *Anthriscus sylvestris*, ground-ivy *Glechoma hederacea* and rhododendrons.
Early summer: cat's-ear *Hypochaeris radicata*, mouse-ear hawkweed *Pilosella officinarum*, birds-foot trefoils *Lotus* spp., oxeye daisy *Leucanthemum vulgare*, foxglove *Digitalis purpurea*, bramble *Rubus fruticosus* agg., roses *Rosa* spp. and broom *Sarothamnus scoparius*.
Mid to late summer: thistles (*Cirsium* and *Carduus*), ragworts *Senecio* spp., knapweeds *Centaurea* spp., hogweed *Heracleum sphondylium*, upright hedge parsley *Torilis japonica*, clovers *Trifolium* spp., vetches *Vicia* spp., rosebay willowherb *Chamerion angustifolium*, ling *Calluna vulgaris* and specifically at Elveden: parsnip *Pastinaca sativa*, mulleins *Verbascum* spp., viper's bugloss *Echium vulgare*, field scabious *Knautia arvensis* and mignonettes *Reseda* spp..
Late summer–early autumn: hawkbits *Leontodon* spp., scentless mayweed *Tripleurospermum inodorum* and late flowers from the previous category.

Persistence and timing were very important for producing good lists. Some mining bees, for example, peak very early in the year when the sallow and blackthorn are in blossom. Finding bees with very narrow foraging habits required careful surveillance of specific flowers, including mignonettes for *Hylaeus signatus* (Panzer), field scabious for *Andrena hattorfiana* (F.) and heathers for *Andrena fuscipes* (Kirby) and *Colletes succinctus* (L.). For genera containing species that were indistinguishable in the field, such as *Sphecodes*, *Lasioglossum*, smaller *Andrena*, *Crossocerus*, *Pemphredon* and *Chrysis*, reasonably-sized series were obtained from as many different parts of the site as possible for critical checking under a microscope. A day in the field typically constituted 5–6 hours, including a short lunch break and walks between different compartments.

Three parameters were then used to assess the quality of the assemblages present:

(i) Species richness. This figure was the total number of bee and wasp species recorded per site during the survey period.
(ii) The presence of rare species (Red Data Book and Nationally Scarce species). These were taken from Falk (1991). However, to allow for the fact that some of these gradings are known to be misleading, an asterisk has been placed against the obviously misgraded species in the Appendix and a bracketed re-grade suggestion that is more realistic given afterwards. A rarity score (RS) was evaluated for each site by assigning 100 points to Red Data Book species and 50 points to Nationally Scarce species (following Ball, 1986). Regional scarcity, which can be used in addition to the above grades, could not be assessed easily for these sites due to the lack of county data to hand. The rarity score was divided by the total number of species at a site to produce a species quality index (SQI) which is stated to even out variable recording coverage across multiple sites. These calculations were made for each site following adjustment for obvious misgradings.
(iii) The quality of certain habitat-associated assemblages. A variety of habitat-linked insect assemblages can be used to compare site quality within certain defined parameters. At the sites studied here, these included:

- **Acidophilous species** – species strongly associated with heathland and acid grassland, not simply sandy soils, the presence of which can be used for monitoring the quality of any existing heathland or of any heathland

restoration (species highlighted as '**Acidoph**' in the Appendix). It includes two species specifically requiring heathers for foraging, *Andrena fuscipes* and *Colletes succinctus*.

- **Calcicolous species** – species strongly associated with chalk or limestone habitats (highlighted as '**Calc**' in the Appendix), a useful parameter for assessing and monitoring calcareous habitat in Breckland plantations.
- **Terrestrial snail-associated species** – an insect assemblage that can reflect site quality and includes a number of bees that nest in empty snail shells (highlighted as '**Sn**' in the Appendix). These bees are also calcicoles, though this is not the case with some snail-associated flies and beetles.
- **Aerial nesting solitary species** (excluding cleptoparasites) – to reflect the quantity and variety of dead wood and other opportunities for aerial nesters.
- **Ground-nesting solitary species** (excluding cleptoparasites) to reflect the quantity, quality and variety of ground-nesting conditions.
- **Coastal-biased species** – another useful parameter for Breckland sites which support unusually high concentrations of species most typically associated with coastal dunes (species highlighted as '**Coastal**' in the Appendix).
- **Conifer-associated species** – a useful parameter for some other insect groups (e.g. flies), though only one such species exists within the list – *Passaloecus eremita* Kohl (highlighted as **Conif** in the Appendix).
- **Cleptoparasites** (of both solitary and social species) – which can be converted into a 'cleptoparasitic load' by turning the number of cleptoparasites into a percentage of the total fauna.

Results

Species richness

Large, representative samples of bees and wasps were obtained from all four sites, particularly Elveden, Longleat and Sherwood which were subject to a longer period of study than Whinfell. The data obtained were used to evaluate the quality of the assemblages present at each site. The various scores that underpin this evaluation are presented in Table 1. All the species recorded, and the year(s) are listed in the Appendix, which also furnishes brief notes for the scarcer species, plus any points of interest relating to more frequent ones.

A total of 259 species (excluding *Apis mellifera* L.) was recorded from the four sites, a figure that represents over half of the British bee and wasp fauna and exceeds some county lists. The richest site by far was Elveden, with a total of 203 confirmed species and one unconfirmed one (*Dryudella pinguis* (Dahlbom) – suggested by the presence of its cleptoparasite) based on 11 year's recording. Longleat produced a list of 136 confirmed species plus one unconfirmed one (*Melitta leporina* (Panzer) – suggested by its cleptoparasite) based on ten year's recording. Sherwood produced 124 species based on ten year's recording and Whinfell produced 66 species based on only three year's recording. The Elveden list is one of the best modern site lists in Britain – there are probably only a handful of sites nationally with modern lists exceeding 200 species. Nine species were added to the Elveden list in the final year of recording, suggesting that this list remains incomplete. Elveden also produced two exceptional single day lists of 96 species on 28 July 2002 and 97 species on 19 July 2004. Whilst the lists for the other three sites are somewhat shorter then that for Elveden, they still appear to be very good within their respective counties.

Table 1. Hymenoptera quality scores from the four British Centerparc villages, using a variety of parameters. Rarity scores were adjusted for obvious misgradings of species (see Appendix).

	Longleat	Elveden	Sherwood	Whinfell
Confirmed species (unconfirmed)	136 (137)	203(204)	124	66
Nationally Endangered (RDB1)	0	0	0	0
Nationally Vulnerable (RDB2)	0	2	0	0
Nationally Rare (RDB3)	2	6	0	0
Nationally Scarce (N)	8	34	6	3
Rarity Score (based on RDB & N spp)	600	2500	300	150
Species Quality Index	4.41	12.32	2.42	2.28
Aerial-nesting solitary species (%)	29 (21.3)	49 (24.1)	29 (22.6)	12 (18.2)
Ground-nesting solitary Species	42	69	55	17
Calcicolous species	3	6	0	0
Snail-nesting species	2	2	0	0
Acidophiles	6	6	10	6
Coastal-biased species	0	7	0	0
Conifer-associated species	0	0	1	0
Cleptoparasites (load)	30 (22.1)	45 (22.2)	26 (20.1)	19 (28.8)

The presence of rare and scarce species

Some very significant records were obtained, including several species additional to the recently published list for Cumbria (Robertson, 2005). These scarcer species are highlighted in the Appendix. All sites produced records of rare or scarce species, though the number of these and the resultant SQI value varied greatly (see Table 1). Elveden produced a rarity score of 2500 derived from the presence of eight Red Data Book species and 34 Nationally Scarce ones. Longleat scored 600 due to the presence of two Red Data Book species and eight Nationally Scarce ones. Sherwood scored 300 due to the presence of six Nationally Scarce species and the under-recorded Whinfell scored 150 due to the presence of three Nationally Scarce species. Converting the scores to a species quality index gave the same ranking, though this calculation has been found by the author to create quite distorted impressions of relative site quality on a number of occasions. In this study, the SQI values suggested that Sherwood and Whinfell were of similar quality. But this is quite unlikely given the northern location and less sandy nature of Whinfell and would probably be confirmed with more surveying of Whinfell.

The quality of some key species assemblages

Seventy-one aerial nesters (excluding cleptoparasites), seven calcicoles, two snail-users, 15 acidophiles and seven coastal-biased species were recorded. The numbers of these found at each site are summarised in Table 1. Elveden had the highest number of aerial nesters (49) and the highest proportion of aerial nesters within its fauna, though the latter figure was only slightly greater than the figures for Sherwood and Elveden. Elveden also had the greatest number of calcicoles (6) with Longleat being the only other site capable of supporting any (3). Both sites supported two snail-users, which are both strongly calcicolous (*Osmia bicolor* (Schrank) and *Hoplitis spinulosa* (Kirby)). Only Elveden was capable of supporting any coastal-biased species, an assemblage of seven. Sherwood produced the highest number of acidophilous species (10), with the other three sites each supporting six. Sherwood

was the only site found to be supporting the conifer-requiring *Passaloecus eremita*. The number of cleptoparasites was greatest at Elveden, though as a proportion of the total aculeate fauna, the 'load' was not significantly greater than that for either Longleat or Sherwood. By comparison, the meagre fauna of 19 cleptoparasites at Whinfell actually constituted a load of nearly 30% of the entire fauna, a value much higher than the other three sites.

Discussion

The rarity scores for Elveden, Longleat and Sherwood indicate that they should be considered important sites for aculeate Hymenoptera. Rarity scores for some other key sites recently subject to comparable surveys, based on modern lists of Red Data Book and Nationally Scarce species, include 1200 for Highgate Common, Staffordshire (a heathland supporting the richest bee and wasp fauna currently known in the West Midlands) and 650 for the Bishops Hill-Bishops Bowl complex, Warwickshire (a limestone site supporting the second richest bee and wasp fauna currently known in the West Midlands) (Falk, 2006). The rarity score for Elveden should be viewed as reflecting a bee and wasp assemblage of national significance.

Factors influencing species richness

A number of factors appeared to influence the different species richness of the four sites:

(i) **The extent and quality of floristically diverse habitat.** Elveden currently supports considerably more semi-natural grassland than the other three Centerparcs. What is more, this grassland has formed on calcareous chalky sands and has a character resembling that of other classic Breckland sites such as Wangford Warren, Red Lodge and East Wretham Common. These grasslands are characterised by very rich floras containing both calcicoles and typical heathland plants and with high densities of flowers throughout summer months that attract a rich fauna. The abundance of umbellifers such as hogweed and parsnip was found to be critical. Parsnip, in particular, plays an important role as a forage plant for bees and wasps at Breckland sites, and it was largely the persistent surveying of some very large stands at Elveden that produced the two exceptional single day lists noted above. Hogweed was present at parts of Whinfell and was of major importance there, but Longleat and Sherwood supported very few umbellifers, which almost certainly reduced the potential of these sites for bees and wasps. As a rule of thumb, acidic soils tend to be less floristically diverse and produce a less continuous sequence of useful flowers compared with calcareous sites, though the heather flowers that can be present in late summer are very important. Spring blossoming shrubs such as *Salix*, *Prunus* and *Ulex* are very important in March and April for *Andrena* and *Nomada* bees. But whilst these shrubs occurred widely at Elveden and Sherwood, they were scarce at Longleat and Whinfell, which was reflected in their much smaller spring bee faunas. But aside from the variety of flowers present, the sheer extent of open habitat within these coniferous settings was probably crucial as many bee and wasp species cannot survive in small patches of otherwise suitable habitat. This is borne out by the author's work at various Warwickshire plantations that are not diversified or only slightly so. Simple ride systems and small clearings tend not to support rich aculeate faunas (e.g.

Hay Wood SP2071 and Birchley Hays Wood SP2684), but the fauna will increase where wider rides are created and larger, more permanent patches of grassland are present (e.g. Brandon Wood SP3876 and Oversley Wood SP1056).

(ii) **Geographic location.** Most bees and wasps have a southern bias (often a south-eastern bias), which means that one tends to find smaller assemblages of aculeates further north. It is not a strict rule, as many other variables can affect the fauna of a site and result in some relatively rich sites in the north and poor sites in the south. The best sites in the Brecks and southern heathland districts support over 200 species, whilst the best ones in the Midlands support about 130 species (S. Falk data) and few sites in northern England have lists exceeding 100 species (M. Archer data). The influence of geographical location is clearly reflected in the Centerparc data, even if the more calcareous nature of Elveden and the under-recording of Whinfell are allowed for. But it should be noted that Whinfell supported three northern-biased species (*Bombus monticola* Smith, *Crossocerus leucostomus* (L.) and *Passaloecus monilicornis* Dahlbom) that would not be anticipated from the other three sites.

(iii) **The surrounding countryside.** All four Centerparcs were located within much larger tracts of conifer plantation and other habitats of varying ecological character and quality. Elveden was most fortunate in its location, lying adjacent to the 570 ha Lakenheath Warren SSSI, with Wangford Warren and several other important chalk-heath sites within a few miles. This almost certainly facilitated the colonisation of new habitats created at this Centerparc over the past 15 years and allowed colonisation by some surprisingly scarce species. It is best to view Breckland bee and wasp assemblages as being comprised of numerous local populations (metapopulations) that can move around the Breckland landscape with different levels of efficiency, taking advantage of any new suitable habitat that forms reasonably close to an existing colony of a given species. This would help to explain why species such as *Andrena hattorfiana* and *Melitta haemorrhoidalis* (F.) were recorded at Elveden, even though only small quantities of their forage plants were present (less than would be needed for viable, permanent populations). It is possibly also the reason why so many species were only recorded once despite careful surveying over many years. Longleat is located within an area that lost much of its former heathland through coniferisation. The new heathland created is currently very isolated, and the bee and wasp fauna it supports is unexceptional in a southern England context, presumably because there are few nearby sources for such species. The heathland here notably lacked the two heather specialist bees found at Sherwood and Elveden, sites which both occur within districts characterised by much heathland. Sherwood's location within a district supporting particularly extensive areas of lowland heathland may explain why its new heathland supported the highest number of acidophiles, including two heather–associated bees, and why more ground nesting solitary species were present than Longleat (55 vs. 42).

(iv) **The availability of dead wood and other aerial nesting opportunities.** Whilst the majority of bees and wasps present were ground-nesters, aerial nesters still comprised a significant proportion of the fauna. The number of aerial nesting species was partially dictated by the quantity and variety of dead wood and hollow stems, though the previous three factors also exerted strong influences. The high number of aerial nesters at Elveden in part reflected the greater amount of dead wood (both large log piles and some standing dead trees), key

shrubs such as elder *Sambucus nigra*, bramble and roses (which produce hollow twigs), and herbs such as umbellifers and thistles (good at producing hollow stems).

Factors affecting the presence of rare and scarce species

The main factors influencing the presence of so many scarce species at Elveden were probably much the same as those influencing its greater species richness. The majority of rare and scarce species have southern biases, which explains the greater number of such species at Longleat than Sherwood, despite the similar length of their species lists.

Factors affecting the quality of some key species assemblages

Underlying geology and site history were particularly important for the presence of calcicoles and acidophiles. The chalky soils of Elveden produced calcareous vegetation in many places supporting good stands of calcicolous plants such as wild parsnip, mignonettes, viper's bugloss and field scabious, and attracting six aculeate species typically associated with chalk and limestone. A small balancing pool at Longleat was the only other calcareous habitat found within the four villages, but its limited size and isolation from other calcareous habitat meant it could only support three calcicoles. For acidophiles, the area and quality of heather-rich vegetation or acid grassland were very important, and the scores more or less mirror this, with Sherwood supporting the most. The presence of coastal-biased species was completely restricted to Elveden, and such species have a high proportion of their inland populations within the Breckland. This may be linked to the particularly loose sands associated with many parts of the Brecks and possibly also the historical presence of mobile dunes here, for example at Wangford Warren. Descriptions from the late 17th century liken parts of the Breckland region to the deserts of Libya with sand sometimes engulfing the village of Santon Downham to a depth of at least 2.75 m (Wright, 1668). The cleptoparasitc load value is sometimes portrayed as a quality indicator. However, the results from this study suggest it is not reliable, as the load was highest for the least interesting site judged on most other parameters (Whinfell) and that for the exceptional Elveden was not significantly higher than Longleat or Sherwood.

Encouraging bee and wasp richness in coniferous plantations

One of the broader objectives of the study was to propose land management options that could increase aculeate biodiversity. The following is a simple checklist of techniques that can be considered when attempting to promote bee and wasps assemblages in coniferised settings, based on the author's experiences at the four Centerparcs and plantations in Warwickshire.

1. Maximise the amount of grassland and heathland in and around plantations

- Scallop rides and manage rotationally to diversify conditions – vary the orientation of such rides where possible, remembering that sunny, south-facing edges are more valuable for bees and wasps than shaded north-facing ones.
- Create blocks of permanent grassland and manage to enhance floristic diversity, using natural regeneration where sufficient, but consider carefully sourced seed mixtures where not.

- Create blocks of heathland where soils are suitable and manage to promote heathers and areas of bare, sandy ground. Former conifer plantation can support good heathland regeneration if excess litter and brash are removed (Walker *et. al.*, 2004; pers. obs.).
- Control scrub encroachment (gorse scrub is particularly invasive at Sherwood and Elveden).
- Manage grasslands using a variety of regimes to create varied conditions and to find which approaches produce the best responses. Consider occasional scarifying to break up coarse grassland and promote disturbance-loving plants. Some areas of grassland at the Centerparcs have lost diversity as they have matured, but scarifying has produced very good results at Elveden.

2. Promote dead wood and aerial nesting opportunities

- Create log piles in sunny locations, preferably in different parts of the site.
- Encourage some standing dead timber such as dead trees or stumps (including up-turned root plates with their bases facing the sun).
- For stem nesters, encourage key shrubs such roses, elder, bramble, also stands of herbaceous plants such as umbellifers and thistles.

3. Promote key forage plants

- Blossoming shrubs and trees such as cherries, blackthorn and other *Prunus* spp., willows, crab apple, hawthorns, elder, *Viburnum* spp. and maples can be valuable forage plants. Introduce if necessary.
- Umbellifers, especially hogweed, cow parsley, hedge parsley and (at Breckland sites) wild parsnip. Areas with richer soils, such as places used for dumping and outside storage (including top-soil storage), around log piles, around car parks etc. can be particularly suitable for hogweed and cow parsley.
- Heathers – very important in late summer.
- A good variety of composites, legumes, labiates, mignonettes and flowers listed earlier in this paper, as appropriate to a site.

4. Others

- Thin existing woodland to encourage a ground flora – which may promote useful forage plants such as bramble, bilberry and foxglove.
- Produce topographic features – such as south-facing banks and slopes, pits and trenches, especially where the ground is sandy and in sunny, sheltered locations. Avoid top-soiling such locations.
- Embrace the role of rabbits, moles and human trampling – all of which can enhance open habitats for bees and wasps by promoting nesting areas and disturbance-loving flowers. Even well-trodden paths can support good nesting colonies, but avoid placing artificial surfaces on paths if unnecessary.

Kirby (1992) furnishes a more detailed account of woodland management for invertebrates, including the management of rides and clearings, promotion of dead wood habitats, and importance of trees and shrubs. The above list can also be applied to broadleaved plantations e.g. blocks of poplars, and to semi-natural broadleaved woodland.

Acknowledgements

The author is particularly grateful to Barry Collins and Centerparcs Ltd for commissioning this work and providing so much support. Mike Edwards provided useful information and advice during the preparation of this paper.

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Appendix. The species recorded with notes

The following list includes the Centerparc at which each species was recorded (LONG – Longleat, ELV – Elveden, SHERW – Sherwood, WHINF – Whinfell) and the year of the record(s) i.e. 96 = 1996, 03 = 2003. The number of years gives some indication of the success with which a species can exploit diversified coniferous settings. Some full dates are given for very important records. Other abbreviations include: **RDB1, 2** or **3** plus **N** – the rarity grading, **Acidoph** – a species strongly associated with heathland and acid grassland, **BAP** – a Biodiversity Action Plan Priority Species (UK Biodiversity Steering Group, 1995), **Calc** – a strongly calcicolous species, **Coastal** – a species strongly associated with coastal dunes, and **Conif** – a species strongly associated with conifers. A rarity value expressed **RDB3* (N)** means it is a species currently graded as RDB3 that requires downgrading to Notable in the opinion of the author. Notes have been provided to indicate some of the key requirements of the individual species within such settings, particularly the scarcer ones.

Chrysididae

Chrysidid wasps are mostly parasitoids of the larvae of crabronid and non-social vespid wasps (*Cleptes* excepted) with individual species usually associated with either ground-nesting hosts or aerial nesting hosts.

Chrysis angustula Schenck LONG: 04, ELV: 97, 02, 03. *Chrysis* wasps mostly attack vespid and crabronid wasps. Dead tree trunks, stumps and log piles are important for the hosts of all the species listed except *C. illigeri* (Wesmael).

C. ignita (L.) ELV: 94.
C. illigeri (Wesmael) N LONG: 98, ELV: 96, 97, 98. Attacks the ground-nesting *Tachysphex pompiliformis*. Good numbers recorded on sandy calcareous grassland at Elveden in some years.
C. impressa Schenck ELV: 96, 97, WHINF: 03 (seemingly a new county record).
C. mediata Linsenmaier ELV: 99.
C. ruddii Schuckard WHINF: 02 (seemingly a new county record).
Cleptes nitidulus (F.) N ELV: 96. *Cleptes* species are parasites of sawfly larvae.
C. semiauratus (L.) N* **(no status)** LONG: 98, ELV: 97, SHERW: 95, 96, 99. Mostly swept from sallow carr and shaded undergrowth.
Elampus panzeri (F.) **Acidoph** LONG: 97, ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04, SHERW: 99, 01, WHINF: 02 (seemingly a new county record). Attacks the ground-nesting *Mimesa equestris* (F.). Particularly abundant at Elveden on sandy calcareous grassland.
Hedychridium ardens (Latreille *in* Coquebert) LONG: 97, ELV: 96, 98, SHERW: 97. Attacks *Tachysphex pompiliformis* (Panzer) which nests in sandy ground.
H. cupreum (Dahlbom) N ELV: 94. The host wasp *Dryudella pinguis* was not actually recorded at Elveden but can be easily overlooked. Sandy ground is required.
H. roseum (Rossi) **no status* (N) Acidoph** ELV: 04. Requires sandy ground with plentiful *Astata* and *Tachysphex* wasps.
Hedychrum niemelai Linsenmaier **RDB3** ELV: 02, 03, 04. Requires sandy grounds with plentiful *Cerceris* wasps.
Omalus puncticollis (Mocsáry) N LONG: 04, ELV: 04. Associated with stem or dead wood-nesting crabronid wasps.
Trichrysis cyanea (L.) LONG: 95, 97, 01, ELV: 94, 96, 01, 02, 04, SHERW: 96, WHINF: 03 (seemingly a new county record). Requires good populations of *Trypoxylon* wasps, though possibly uses other aculeates such as *Hylaeus* bees (M. Edwards, pers. comm.) and particularly associated with root plates of felled conifers at Longleat; also log piles at some of the other sites.

Tiphiidae

Tiphia femorata F. ELV: 94, 95, 96, 02, 04. Requires sandy ground and an input of dung (the larvae are presumed predators of dung beetle larvae). The Elveden population was very strong in some years, but seemed to crash in others.
T. minuta Vander Linden N* **(no status)** LONG: 01, ELV: 96, 99, SHERW: 01, WHINF: 02, 03. Possibly associated with rabbit dung (its larvae possibly attacking the beetle larvae associated with such dung).

Mutillidae

Myrmosa atra Panzer LONG: 96, 97, 98, 03, 04, ELV: 94, 96, 97, 98, 01, 02, 03, 04, SHERW: 96, 99, 01, 03, 04, WHINF: 02. Associated with ground-nesting bees and wasps in open habitats with bare or sparsely-vegetated light soils.

Pompilidae

Most of the pompilids listed here require sparsely-vegetated ground fully exposed to the sun (especially sand or dry earth on south-facing slopes supporting plentiful prey spiders) except *Dipogon subintermedius* which is associated with dead wood and trees.

Anoplius infuscatus (Vander Linden) ELV: 99.
A. nigerrimus (Scopoli) LONG: 97, 98, 00, SHERW: 99.
A. viaticus (L.) LONG: 97, ELV: 94, 95, 96, 98, 00, 02, 03, 04, SHERW: 95.
Arachnospila anceps (Wesmael) LONG: 97, 98, ELV: 95, 96, 97, 99, 02, 03, 04, SHERW: 95, 00, 01, 02, 03, 04, WHINF: 03.
A. minutula (Dahlbom) **N Calc** ELV: 98, 99.
A. spissa (Schiødte) LONG: 01, ELV: 96, 97, 99, 00, SHERW: 96, 97, 99, WHINF: 03, 04.
A. trivialis (Dahlbom) ELV: 95, 96, 04.
A. wesmaeli (Thomson) **N** ELV: 96, 04.
Caliadurgus fasciatellus (Spinola) LONG: 97.
Dipogon subintermedius (Magretti) ELV: 95.
Episyron rufipes (L.) ELV: 94, 95, 96, 97, 98, 01, 04.
Evagetes crassicornis (Schuckard) ELV: 94, 95, 96, 98, 99, 02, 04, SHERW: 01, WHINF: 03, 04. *Evagetes* species are cleptoparasites of other pompilids and their presence tends to indicate good conditions are present for pompilids.
E. dubius (Vander Linden) **N** ELV: 96, 98.
Priocnemis coriacea Dahlbom ELV: 94.
P. gracilis Haupt **N** ELV: 96.
P. hyalinata (F.) **N** ELV: 01, 02.
P. perturbator (Harris) LONG: 96, ELV: 94, 96, 02, SHERW: 97, 00, 02, WHINF: 03.
P. pusilla Schiødte ELV: 96, 04.
P. schiodtei Haupt **N Acidoph** SHERW: 95, 99, 03. At this and other Midlands localities, this pompilid showed a strong association with a *Calluna*, acid grassland and bare sand mosaic, though it is uncertain if it shows this habitat fidelity in other regions.
P. susterai Haupt LONG: 01, ELV: 99, 00, 02, SHERW: 00.

VESPIDAE

The non-social vespids *Ancistrocerus*, *Gymnomerus*, *Microdynerus* and *Symmorphus* are aerial nesters that rely variously on dead wood and hollow stems. The social wasps typically form nests either within foliage (*Dolichovespula*) or within cavities (*Vespa* and *Vespula*) and produced some particularly good assemblages at Elveden, Longleat and Sherwood.

Ancistrocerus gazella (Panzer) LONG: 98, ELV: 03, SHERW: 95. *Ancistrocerus* species are particularly dependent upon hollow stems of plants like *Rubus* and elder and also the cavities associated with dead wood and old trees. Log piles often attract several species.
A. nigricornis (Curtis) ELV: 94, 95, 96, 02, 04.
A. oviventris (Wesmael) LONG: 97, 04, ELV: 96.
A. parietinus (L.) ELV: 04, SHERW: 97.
A. parietum (L.) LONG: 95, SHERW: 96, 99.
A. scoticus (Curtis) WHINF: 04.
A. trifaciatus (Müller) LONG: 01, ELV: 96, 97, 99, 04, SHERW: 95, 96, 97, 01, 02, WHINF: 03
Dolichovespula media (Retzius) **N* (no status)** LONG: 03, ELV: 94, 95, 02, 03, 04, SHERW: 95, 04. Often numerous at Elveden, the males liking *Pastinaca* flowers in particular.

D. norwegica (F.) LONG: 98, SHERW: 95, WHINF: 02, 03, 04. Frequent at the last site, reflecting a northern bias.

D. saxonica (F.) **RDBK* (no status)** LONG: 00, 01, 03, 04, ELV: 94, 95, 98, 99, 02, 03, 04, SHERW: 04. This recent colonist clearly thrives in these settings and has been seen in good numbers at the three listed sites in certain years – the males usually congregating on umbellifer flowers.

D. sylvestris (Scopoli) LONG: 95, 03, 04, ELV: 94, 95, 98, 03, 04, SHERW: 95, 96, 98, 00, 01, 03, 04, WHINF: 02.

Gymnomerus laevipes (Shuckard) LONG: 97, 98, 00, 01. Dependent upon hollow stems of plants such as *Rubus*, *Arctium*, *Sambucus* and thistles.

Microdynerus exilis (Herrich-Schäffer) **N** ELV: 02. Typically nests in old beetle holes in dead wood including fence posts, but sometimes in the ground (M. Edwards, pers. comm.).

Symmorphus bifasciatus (L.) ELV: 94, 95, 03, 04, SHERW: 95. The nesting habits of *Symmorphus* species resemble *Ancistrocerus*.

S. gracilis (Brullé) ELV: 94, 96, 97, 98, 01, SHERW: 01.

Vespa crabro L. LONG: 99, 00, 04, ELV: 95, 99, 02.

Vespula germanica (F.) SHERW: 04. The lack of records for this generally common species is noteworthy.

V. rufa (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 04, ELV: 94, 95, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 00, 03, WHINF: 03. Particularly favoured tall grasslands and heathland at these sites, though no sign of its cleptoparasite *V. austriaca* (Panzer) at Whinfell, which would have been expected at such a northern location.

V. vulgaris (L.) LONG: 95, 96, 97, 99, 00, 01, 02, 04, ELV: 94, 95, 96, 97, 98, 00, 02, 03, 04, SHERW: 95, 97, 98, 00, 02, 03, 04. Utilised a wide range of habitats including the lodges and more heavily developed parts of the site.

Sphecidae

Sphecid wasps require bare and sparsely-vegetated sandy ground for nesting and stock their cells with caterpillars obtained from nearby vegetation.

Ammophila sabulosa (L.) LONG: 95, ELV: 94, 95, 96, 97, 98, 99, 02, 03, 04, SHERW: 95, 96, 97, 99, 01. Requires a mosaic of bare, sandy ground together with patches of grassland and/or heather. The Longleat record is significant in a Wiltshire context.

Podalonia affinis (Kirby) **RDB3* (N) Coastal** ELV: 96. Requires sparsely-vegetated sandy ground with most records for coastal dunes plus the Brecks.

Crabronidae

A requirement for sparsely-vegetated sandy ground features in many of these solitary wasps, whilst a smaller but still sizeable assemblage nest in dead wood (including log piles) or hollow plant stems. Hunting occurs in the surrounding vegetation including grassland, shrub and tree foliage and on flowers, depending on the species involved, with prey ranging from aphids and tiny spiders through to grasshoppers, beetles, flies and other aculeates, depending on the species.

Argogorytes mystaceus (L.) LONG: 00, 01, 02, 04, SHERW: 99, 01, 03, WHINF: 03, 04. Requires areas of longer grass with plentiful cuckoo-spit (it stocks its cells with the nymphs contained within), perhaps especially at woodland edge.

Astata boops (Schrank) LONG: 97, 01, ELV: 98, 01, 02, 04. Likes sparsely-vegetated ground, including sands and dry clays.

Cerceris arenaria (L.) LONG: 96, 03, ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04. Most *Cerceris* species require sandy ground, such as well-trodden (but not churned) footpaths for nesting. A very strong population of *C. arenaria* occurred at Elveden with some very large nesting aggregations.

C. quinquefasciata (Rossi) **RDB3 BAP** ELV: 94, 95, 96, 98, 01, 02, 03, 04. Elveden supported a very strong population of this rare species, which forages and hunts on umbellifers such as *Torilis* and *Pastinaca*.

C. ruficornis (F.) **No status* (N)** ELV: 03, 04. Seemingly absent at Elveden when the study started, but found in reasonable numbers in the final two years.

C. rybyensis (L.) LONG: 97, 98, 01, 03, 04, ELV: 94, 96, 97, 98, 01, 02, 03, 04. This species can also utilise non-sandy sites with dry clays.

Crabro cribrarius (L.) ELV: 94, 95, 96, 97, 01, 02, 03, 04, SHERW: 95, 96.

C. peltarius (Schreber) ELV: 94, 96, 97, 99, 00, 02, 04, SHERW: 96, 99, 01, 03, 04.

Crossocerus annulipes Lepeletier & Brullé ELV: 94, 95, 96.

C. capitosus (Schuckard) ELV: 96.

C. cetratus (Schuckard) LONG: 01, ELV: 95, 96, 00, 03, SHERW: 02, 03, WHINF: 04. This species particularly favours log piles for nesting.

C. dimidiatus (F.) ELV: 96.

C. distinguendus (A. Morawitz) **N** ELV: 04. Its late discovery at Elveden corresponds with a marked expansion of its range nationally in recent years. The complete lack of records for the closely-related and widespread *C. elongatulus* (Vander Linden) is noteworthy.

C. leucostomus (L.) **N** WHINF: 02, 03, 04. A northern species with a strong colony at Whinfell associated with a large log pile.

C. megacephalus (Rossi) LONG: 01, 95, ELV: 96, 99, 03, SHERW: 97, WHINF: 02.

C. nigritus Lepeletier & Brullé ELV: 02, 04.

C. ovalis Lepeletier & Brullé LONG: 97, ELV: 02, 04, SHERW: 01, 04, WHINF: 03. Needs sparsely-vegetated ground, typically on sand and dry clays.

C. palmipes (L.) **N** ELV: 01, 02, 03.

C. podagricus (Vander Linden) LONG: 97, ELV: 94, 96, 97, 01, 02, 03, 04, SHERW: 97, 99.

C. pusillus Lepeletier & Brullé LONG: 97, 03, ELV: 99, 01, 03, SHERW: 98, 99, WHINF: 03.

C. quadrimaculatus (F.) LONG: 97, 98, 01, 03, ELV: 96, 04, SHERW: 98, 03, 04. Requires particularly sandy areas.

C. styrius (Kohl) SHERW: 97.

C. wesmaeli (Vander Linden) ELV: 94, 95, 96, 01, 02, 04.

Diodontus luperus Schuckard LONG: 97. *Diodontus* species require sparsely-vegetated sandy ground or dry clays for nesting.

D. minutus (F.) ELV: 96, 97, 98, 01, 02, 03, 04.

D. tristis (Vander Linden) ELV: 99.

(*Dryudella pinguis* (Dahlbom) ELV: presence suggested by recording of its chrysidid parasite *Hedychridium cupreum*)

Ectemnius cavifrons (Thomson) LONG: 03, ELV: 94, 95, 96, 97, 01, 02, 04, SHERW: 97, 04, WHINF: 02, 03. *Ectemnius* species require dead wood such as old stumps and log piles for nesting and hunt Diptera from foliage and flowers (especially umbellifers).

E. cephalotes (Olivier) ELV: 95, 02, 04.

E. continuus (F.) LONG: 95, 98, 01, 03, ELV: 94, 96, 00, 03, 04, WHINF: 04.

E. lituratus (Panzer) LONG: 03, ELV: 02, 04. The data for these two sites plus other locations studied by the author suggests this species is currently expanding in southern Britain.

E. ruficornis (Zetterstedt) **N** ELV: 04. This and the next species were abundant on *Pastinaca* and *Heracleum* flowers in the final year of the study.

E. sexcinctus (F.) **N** ELV: 04.

Entomognathus brevis (Vander Linden) LONG: 03, 04, ELV: 94, 96, 98, 01, 02, 03, 04, SHERW: 01. Requires sparsely-vegetated ground on light soils.

Gorytes laticinctus (Lepeletier) **RDB3** LONG: 19.vii.97. A very significant record – one of very few for Wiltshire. Recorded from a gravelly depression with invading scrub and bramble.

Harpactus tumidus (Panzer) LONG: 97, 01, ELV: 94, 95, 96, 98, 02, 03, 04, SHERW: 99, 01, WHINF: 02, 03. Requires sparsely-vegetated ground on light soils.

Lindenius albilabris (F.) LONG: 97, 01, 02, 03, 04, ELV: 94, 96, 01, 03, 04, SHERW: 95, 96, 99, 01, 03. Requires sparsely-vegetated ground on light soils.

Mellinus arvensis (L.) ELV: 95, SHERW: 98, 04, WHINF: 02. Requires sparsely-vegetated ground on light soils.

Mimesa bicolor (Jurine) **RDB2** ELV: 6.vii.03. *Mimesa* species require sparsely vegetated ground on light soils. This is a highly significant record.

M. equestris (F.) **Acidoph** LONG: 97, 98, 01, 02, 03, 04, ELV: 94, 95, 96, 98, 01, 02, 03, 04, SHERW: 95, 96, 99, 01, WHINF: 02.

Mimumesa dahlbomi (Wesmael) LONG: 95, 97, 01, ELV: 95, 96, 00, 01, 03, SHERW: 01. Nests in dead wood including log piles.

Nysson dimidiatus Jurine **N** LONG: 97, 01, ELV: 94, 95, 96, 98, 01, 02, 03, 04, WHINF: 02 (seemingly a new county record). The parasite of *Harpactus tumidus*.

N. spinosus (Forster) LONG: 00, SHERW: 97, WHINF: 03. The parasite of *Argogorytes mystaceus*.

Oxybelus argentatus Curtis **N Coastal** ELV: 03. *Oxybelus* species require particularly loose sand in hot locations. *O. argentatus* and *O. mandibularis* are particularly characteristic of coastal dunes but have significant strongholds in the Brecks.

O. mandibularis Dahlbom **N Coastal** ELV: 03.

O. uniglumis (L.) LONG: 95, 97, 98, 01, ELV: 94, 95, 96, 97, 98, 99, 01, 02, 04, SHERW: 95, 96, 99, 01, WHINF: 02, 04.

Passaloecus corniger Shuckard SHERW: 96, 97. *Passaloecus* species are particularly dependent on old beetle burrows in dead wood (though some species use hollow stems) and benefit from log piles and old tree stumps.

P. eremita (Kohl) **Conif** SHERW: 99, 03. This species shows a strong attachment to beetle holes in pine trunks and hunts pine aphids (M. Edwards, pers. comm.).

P. gracilis (Curtis) ELV: 94, 95, 96, 01, 02, 04, SHERW: 96, 01.

P. insignis (Vander Linden) SHERW: 99.

P. monilicornis (Dahlbom) WHINF: 02.

P. singularis Dahlbom LONG: 04, ELV: 01, 02.

Pemphredon inornata Say LONG: 95, 01, 02, ELV: 96, 01, SHERW: 96, 98, WHINF: 03. *Pemphredon* nest in dead wood such as log piles and tree stumps, also hollow stems.

P. lethifera (Schuckard) ELV: 95, 04, SHERW: 95, 01.

P. lugubris (F.) ELV: 95, 02.

P. morio Vander Linden **N** LONG: 97.

Psenulus concolor (Dahlbom) ELV: 96. *Psenulus* sp. nest in dead wood or hollow stems.

P. pallipes (Panzer) LONG: 01.

Rhopalum clavipes (L.) LONG: 04, ELV: 99, SHERW: 99. *Rhopalum* wasps nest in hollow stems and dead wood.

R. coarctatum (Scopoli) ELV: 01, SHERW: 96, 01.

Spilomena curruca (Dahlbom) LONG: 01, 02. *Spilomena* wasps nest in hollow stems and dead wood.

S. troglodytes (Vander Linden) ELV: 95.

Stigmus pendulus Panzer **RDBK* (N)** SHERW: 03. *Stigmus* wasps nest in hollow stems and dead wood.

S. solskyii Morawitz, A. LONG: 03, ELV: 94, 03.

Tachysphex pompiliformis LONG: 97, ELV: 96, 97, 98, 99, 02, 04, SHERW: 97, WHINF: 02, 03. Requires sparsely-vegetated, sandy areas with plentiful grasshoppers. Supports several scarce cleptoparasitic aculeates, most notably at Elveden.

Trypoxylon attenuatum Smith, F LONG: 95, 97, 00, 01, 03, ELV: 96, 00, 02, 04, SHERW: 95, 96. *Trypoxylon* wasps nest in hollow stems and dead wood.

T. clavicerum Lepeletier & Serville ELV: 96, 97.

T. medium de Beaumont ELV: 04.

T. figulus (L.) sensu stricto WHINF: 03.

T. 'figulus' sensu lato ELV: 95, SHERW: 96, 97.

APIDAE

The bee fauna is dominated by ground-nesting solitary species, notably of the genera *Andrena*, *Lasioglossum*, *Halictus*, *Colletes* and *Melitta*, plus their cleptoparasites within the genera *Nomada*, *Sphecodes* and *Epeolus*. Species of the genera *Megachile, Osmia*, *Chelostoma* and *Anthidium* mostly nest in wood and support cleptoparasites such as *Coelioxys* species. *Ceratina* and most *Hylaeus* require hollow stems. *Osmia bicolor* and *Hoplitis spinulosus* use empty snail shells. The quantity and diversity of flowers from March to September has an enormous bearing on the diversity of bees present.

Andrena alfkenella Perkins, R.C.L. **RDB3** ELV: 94, 02, 03, 04. At Elveden, it was associated with calcareous grassland on chalky sand and much foraging appeared to take place on *Pastinaca*.

A. angustior (Kirby) LONG: 02, SHERW: 97. Forages on a variety of flowers.

A. barbilabris Kirby ELV: 02, 03, SHERW: 97, 00. Requires particularly sandy ground for nesting, especially well-trodden footpaths. Forages on a variety of flowers.

A. bicolor F. LONG: 97, 98, 01, 03, 04, ELV: 94, 96, 98, 02, 03, 04, SHERW: 96, 99, 00, 01, 03, 04. Bivoltine, foraging on a wide variety of flowers.

A. bimaculata (Kirby) **N Acidoph** ELV: 02, 03, 04. Bivoltine, the spring generation foraging mainly on *Salix* (with males swarming around flowering *Ulex*), whilst the summer generation uses *Rubus* and umbellifers.

A. cineraria (L.) SHERW: 00, 02, 03. Forages on a variety of spring flowers.

A. clarkella (Kirby) SHERW: 96, 00, 03. Forages exclusively from *Salix*.

A. coitana (Kirby) **Acidoph** LONG: 04.

A. denticulata (Kirby) LONG: 97, ELV: 94, 95, 96, 98, 02, SHERW: 95, 99, 01, 03, 04. Forages from composites such as *Senecio*, *Centaurea* and thistles.

A. dorsata (Kirby) ELV: 94, 95, 98–04. Bivoltine, the spring generation foraging heavily from *Ulex* and *Salix* whilst the summer generation is highly polylectic.

A. flavipes Panzer LONG: 97, 04, ELV: 03, 04. Its late discovery at Elveden corresponds with a marked expansion of its range nationally in recent years. Bivoltine, foraging on a wide variety of flowers.

A. fucata Smith, F. LONG: 96, 00, 01, SHERW: 97, 01, 02. Forages mainly on spring-blossoming shrubs such as *Crataegus*.

A. fulva (Müller in Allioni) ELV: 94, 95, 99, 03, SHERW: 96, 00, 03. Forages on a wide variety of spring flowers.

A. fuscipes (Kirby) **Acidoph** SHERW: 98, 04. Forages entirely from heathers, using *Calluna* in a recently created area of heathland at Sherwood.

A. haemorrhoa (F.) LONG: 95, 96, ELV: 94, 95, 99, 01, 02, 03, SHERW: 96, 00, 02, 03, WHINF: 03. Forages on a wide variety of spring and early summer blossoms and flowers.

A. hattorfiana (F.) **RDB3 Calc** ELV: 03, 04. Forages on *Knautia arvensis*, small amounts of which were present along the south edge of Elveden. It is likely that the individuals recorded here were part of a larger colony based at a nearby site.

A. helvola (L.) SHERW: 97. Forages from a wide range of spring blossoms & flowers.

A. humilis Imhoff **N Acidoph** SHERW: 96, 01. Foraged mainly on *Hypochoeris radicata* here and nested in hard-trodden sandy footpaths.

A. labialis (Kirby) LONG: 01. Forages on Fabaceae.

A. lapponica Zetterstedt **Acidoph** SHERW: 97, 00, 02. Requires reasonable quantities of *Vaccinium myrtillus* in the open or within open-structured woodland. *A. lapponica* may also be present at Whinfell Forest which has the most extensive bilberry of all four sites, but which was not surveyed early enough in spring.

A. minutula (Kirby) LONG: 95, 97, 98, 01, 03, 04, ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04. A bivoltine species that forages on a wide variety of flowers, though umbellifers are utilised heavily by the second generation.

A. minutuloides Perkins, R.C.L. **N Calc** ELV: 02, 03, 04. Most Elveden records related to females foraging on umbellifers such as *Pastinaca*.

A. nigroaenea (Kirby) LONG: 96, 00, ELV: 94, 99, 00, 03, SHERW: 96, 97, 00, 02, 03. Forages on a wide variety of spring blossoms and flowers.

A. nitida (Müller) ELV: 03. Forages on a wide variety of spring flowers. The lack of records for this generally common species is noteworthy.

A. ovatula (Kirby) ELV: 94, 95, 96, 99. A bivoltine species foraging on Fabaceae and relying heavily upon *Ulex* in the spring generation and *Lotus*, *Trifolium* and *Vicia* in the second.

A. praecox (Scopoli) SHERW: 00, 03. Forages exclusively on *Salix*.

A. scotica Perkins, R.C.L. LONG: 96, 00, ELV: 94, 95, 99, 00, 02, SHERW: 97, 00, 02, 03, WHINF: 03, 04. Forages on a wide variety of spring and early summer blossoms and flowers.

A. semilaevis Pérez LONG: 04, ELV: 95, 96, 99, 00, 01, 02, 03, 04, WHINF: 02, 04. Forages on a variety of flowers.

A. similis Smith, F. **N** SHERW: 97, 00. Forages mainly on Fabaceae.

A. subopaca Nylander LONG: 96, 98, 01, 03, ELV: 94, 99. Forages on a variety of flowers.

A. synadelpha Perkins, R.C.L. ELV: 99, 00. Forages mainly on spring-blossoming shrubs such as *Crataegus*.

A. tarsata Nylander **Acidoph** LONG: 97, 02, 03, 04. The Longleat population occurred on restored heathland with plentiful *Potentilla erecta*, the forage plant. Rare in Wiltshire.

A. tibialis (Kirby) **N** ELV: 94, 95, 03. Forages on spring blossoms such as *Salix*, *Sarothamnus* and *Ulex*.

A. wilkella (Kirby) LONG: 98, 01, 04, ELV: 96, 97, 00, 04, SHERW: 96, 97, 01, WHINF: 02, 03, 04. Forages on Fabaceae, especially *Lotus*, *Vicia* and *Trifolium*, the univoltine flight period peaking between the two broods of the related *A. ovatula*.

Anthidium manicatum (L.) LONG: 01, 04, ELV: 02, 04, SHERW: 04. Nearly all records related to females foraging on *Lotus*.

Anthophora furcata (Panzer) ELV: 96, 97, 98. Forages on Lamiaceae.

A. plumipes (Pallas) LONG: 00. A species that can thrive in gardens in spring, typically nesting in walls.

Bombus barbutellus (Kirby) LONG: 03, 04, ELV: 94, 96, SHERW: 04. The social parasite of *B. hortorum* (L.).

B. bohemicus (Seidl) LONG: 97, ELV: 94, 95, 97, 00, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 02, 04 The social parasite of *B. lucorum* (L.).

B. campestris (Panzer) LONG: 00, 03, ELV: 94, 96, 99. The social parasite of *B. pascuorum* (Scopoli) and *B. ruderarius* (Müller).

B. hortorum (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 03, SHERW: 95, 96, 97, 99, 00, 01, 02, 03, 04, WHINF: 02, 03, 04. Workers particularly favour deep flowers such as *Digitalis*, *Vicia, Lotus*, *Stachys* and *Cirsium* and will forage more readily in open woodland than most other bumblebees. The queens of most of the non-parasitic *Bombus* (true bumblebees) listed here require spring blossoming shrubs such as *Salix*, *Prunus* and *Ulex*, and flowers like *Taraxacum* and *Lamium* when they emerge from hibernation.

B. jonellus (Kirby) **Acidoph** SHERW: 03, WHINF: 02, 03, 04. Workers foraged mainly on *Calluna* and *Erica* at these two sites.

B. lapidarius (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 03, 04. Workers forage heavily on *Lotus* and *Trifolium*.

B. lucorum (L.) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 02, 03, 04. This species forages heavily on any heathers present. No sign of the closely-related *B. magnus* Vogt at Whinfell (where it might be expected) despite careful screening of *lucorum* specimens.

B. monticola (Smith) **Acidoph** WHINF: 02, 03, 04. Workers forage mainly on *Lotus corniculatus* at Whinfell.

B. pascuorum (Scopoli) LONG: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, WHINF: 02, 03, 04. Workers forage heavily on *Trifolium*.

B. pratorum (L.) LONG: 95, 96, 98, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 01, 02, 03, 04, WHINF: 02, 03, 04. This species is particularly fond of *Rubus* flowers and will use these in thinned-out conifer plantation and broadleaved woodland.

B. ruderarius (Müller) ELV: 94, 95, 97, 03, 04. Workers are easily overlooked amongst *B. lapidarius* and most records relate to males.

B. rupestris (F.) **N* (no status)** LONG: 95, 96, 00, 02, 03. The social parasite of *B. lapidarius*. The males are often abundant on thistle flowers in late summer, but females are less frequently seen.

B. sylvestris (Lepeletier) LONG: 95, 97, 98, 00, 01, 02, 03, 04, ELV: 96, 99, 04, SHERW: 97, 02, 03, 04, WHINF: 02, 03, 04. The social parasite of *B. pratorum* and *B. jonellus*.

B. terrestris (L.) LONG: 95, 96, 98, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 02, 03, 04, WHINF: 02, 03, 04.

B. vestalis (Geoffroy *in* Fourcroy) LONG: 95, 96, 97, 98, 00, 01, 02, 03, 04, ELV: 95, 96, 97, 98, 00, 01, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 01, 03, 04. The social parasite of *B. terrestris*.

Ceratina cyanea (Kirby) **RDB3** LONG: 01. Nests in hollow stems of plants like *Rubus* and *Rosa* in hot locations.

Chelostoma campanularum (Kirby) LONG: 97. At Longleat observed nesting in root plates of fallen conifers and foraging on *Campanularum rotundifolium* within an area of restored heathland.

C. florisomne (L.) LONG: 00. Nests in dead wood and forages exclusively from *Ranunculus* species.

Coelioxys conoidea (Illiger) **Coastal** ELV: 96, 97, 98. *Coelioxys* species are mostly cleptoparasites of *Megachile* bees and tend to be much scarcer then the hosts. This species attacks *Megachile maritima* (Kirby) and like the host, it is more characteristic of coastal dunes.

C. elongata Lepeletier LONG: 04. The cleptoparasite of *M. willughbiella* (Kirby).

C. inermis (Kirby) ELV: 95, 96, 99. The cleptoparasite of *M. centuncularis* (L.).

C. rufescens Lepeletier & Serville **no status* (N)** ELV: 01. A cleptoparasite of *Anthophora* species, presumably *A. furcata* at this site.

Colletes daviesanus Smith, F. ELV: 94, 01, 03, SHERW: 95, 01. Forages on a wide variety of Asteraceae.

C. fodiens (Geoffroy *in* Fourcroy) ELV: 94, 95, 96, 97, 98, 01, 02, 03, 04, SHERW: 95, 98. Forages on a wide variety of Asteraceae.

C. marginatus Smith, F. **N Coastal** ELV: 94, 95, 96, 97, 98, 02, 04. A species associated with very loose sands, typically on coastal dunes but with a significant inland stronghold in the Brecks. Forages on a wider variety of flowers than other *Colletes*.

C. succinctus (L.) **Acidoph** ELV: 95, 96, SHERW: 04. Requires *Calluna* for foraging. Only small amounts of the forage plant occurred at Elveden, and it is likely that the bulk of this population was within the adjacent Lakenheath Warren. The Sherwood population became established following the creation of heathland patches during the 1990s.

Dasypoda hirtipes (F.) **N Coastal** ELV: 04. Requires sandy areas for nesting and forages mainly on *Leontodon*, *Hypochoeris* and similar flowers

Epeolus cruciger (Panzer) ELV: 94, 95, 96, 98, 04, SHERW: 04. A cleptoparasite of *Colletes succinctus* and *C. marginatus*, probably relying mostly on *C. marginatus* at Elveden.

E. variegatus (L.) ELV: 94, 96, 98, 02. A cleptoparasite of *Colletes fodiens* and *C. daviesanus*.

Halictus rubicundus Christ LONG: 95, 96, 00, 01, 03, ELV: 96, 99, 02, SHERW: 95, 99, 00, 01, 03. Forages on a wide variety of Asteraceae.

H. tumulorum (L.) LONG: 95, 97, 00, 01, 03, ELV: 94, 95, 99, 01, 02, 03, 04, SHERW: 95, 98, 01, WHINF: 03, 04. Forages on a wide variety of flowers.

Hoplitis claviventris (Thomson) LONG: 98, 01, ELV: 96, 97, 98, 99, 02, 03, 04. Most records related to foraging on *Lotus*. Nesting occurs in hollow stems.

H. spinulosa (Kirby) **Calc** LONG: 01, 02, ELV: 94, 99, 04. Nests in empty snail shells in sparse turf and forages on a variety of Asteraceae.

Hylaeus annularis (Kirby) **Calc** ELV: 94, 98, 01, 02, 03, 04. Most *Hylaeus* species nest in hollow stems. This species forages on a variety of flowers.

H. brevicornis Nylander LONG: 97, 03, ELV: 94, 95, 96, 02, 03, 04, SHERW: 95, 99, 01. Forages on a variety of flowers.

H. communis Nylander LONG: 97, 98, 01, 03, 04, ELV: 94, 96, 97, 98, 99, 01, 02, 03, 04, SHERW: 96, 01. Forages on a variety of flowers.

H. confusus Nylander LONG: 97, 01, 02, 03, 04, ELV: 03, WHINF: 03. Forages on a variety of flowers.

H. cornutus Curtis **N** ELV: 02, 03, 04. All records were from umbellifer flowers, typically *Pastinaca* and *Heracleum*.

H. pictipes Nylander **N** ELV: 01. Forages on a variety of flowers.

H. signatus (Panzer) **N** ELV: 95, 96, 99, 01, 02, 04. Forages exclusively on *Reseda* sp.

Lasioglossum albipes (F.) LONG: 95, 96, 01, 03, ELV: 98, 99, 01, 02, 04, WHINF: 03, 04. Most *Lasioglossum* species forage on a wide variety of flowers, with some species clearly requiring calcareous grasslands whilst others prefer acidic habitats.

L. brevicorne (Schenck) **N Acidoph** ELV: 99. This species specialises on *Pilosella* and *Leontodon*-type flowers in sandy habitats, typically heathland.

L. calceatum (Scopoli) LONG: 95, 03, ELV: 94, 98, 99, 01, 02, 03, 04, SHERW: 95, 99, 00, 01, 03, WHINF: 02, 03.

L. fratellum (Pérez) **Acidoph** LONG: 95, 96, 97, 00, 01, 02, 03, SHERW: 96, WHINF: 02, 03, 04. Strongly associated with heathland and acid grassland.

L. fulvicorne (Kirby) **Calc** LONG: 03. Strongly associated with calcareous grassland, the Longleat record coming from the only calcareous part of the site.

L. lativentre (Schenck) LONG: 95, 96, 01, ELV: 97, 99, 00, 03, 04.

L. leucopus (Kirby) LONG: 95, 97, 01, 02, 03, ELV: 94, 95, 96, 97, 99, 00, 01, 02, 03, 04, SHERW: 97, 00, 03, WHINF: 02, 04.

L. leucozonium (Schrank) LONG: 95, 96, 97, 00, 01, 02, 03, 04, ELV: 94, 95, 96, 98, 99, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 01. Polylectic but especially fond of *Hypochaeris radicata*.

L. minutissimum (Kirby) LONG: 95, 04, ELV: 94, 96, 98, 99, 02, 03, 04.

L. morio (F.) LONG: 97, 98, 00–04, ELV: 94, 95, 98, 01, 02, 03, 04, SHERW: 97, 03.

L. parvulum (Schenck) LONG: 95, 96, 97, ELV: 94, 95, 96, 99, 04, SHERW: 04.

L. punctatissimum (Schenck) LONG: 95, 96, 97, 98, 00, 01, 02, 03, ELV: 94, 95, 96, 97, 98, 99, 00, 02, 03, 04, SHERW: 95, 96, 97, 98, 99, 00, 04.

L. quadrinotatum (Kirby) **N** ELV: 94, 95, 99.

L. rufitarse (Zetterstedt) **Acidoph** LONG: 95, 96, 97, 01,02, 04, SHERW: 95, 97, 00, WHINF: 02, 03, 04. Shows a strong preference for heathland and acid grassland.

L. villosulum (Kirby) LONG: 95, 96, 00, 01, 02, 03, 04, ELV: 95, 96, 97, 98, 99, 02, 04, SHERW: 95, 97, 98, 99, 00, 01, WHINF: 02, 03, 04.

Megachile centuncularis (L.) ELV: 95, 99. *Megachile* species typically nest in cavities in wood and hollow stems. Most species forage on a wide variety of flowers, though *Lotus* and *Cirsium* featured in many of the records here.

M. ligniseca (Kirby) LONG: 03, ELV: 94, 95, 02.

M. maritima (Kirby) **Coastal** ELV: 96, 98, 02, 03. A species more typical of coastal dunes.

M. versicolor Smith, F. LONG: 97, 98, 00, 01, 04, ELV: 96, 98, 01, 03, 04.

M. willughbiella LONG: 96, 97, 98, 03, 04, ELV: 95, 96, 98, 01, 02, SHERW: 96, 99, 01, WHINF: 03

Melitta haemorrhoidalis (F.) ELV: 95. At Elveden foraged on *Campanula rotundifolium* on sandy calcareous grassland.

M. leporina (Panzer) LONG: presence here assumed from the presence of the *Melitta*-attacking *Nomada flavopicta* (Kirby) and the lack of forage plants for other known *Melitta* hosts such as *M. haemorrhoidalis*. ELV: 94, 98, 03, 04. At Elveden it foraged mostly on *Trifolium repens* in shorter, annually cut grassland.

Nomada fabriciana (L.) LONG: 97, 98, 00, 01, ELV: 94, 00, WHINF: 04. *Nomada* species are cleptoparasites of ground-nesting solitary bees, typically *Andrena* species. This species attacks *A. bicolor*.

N. flava Panzer LONG: 96, 00, ELV: 94, 95, 99, 00, 02, SHERW: 97, 02. Typically attacking *Andrena scotica*.

N. flavoguttata (Kirby) LONG: 96, 98, 03, 04, ELV: 94, 95, 98, 99, 02, 03, 04. A cleptoparasite of *Andrena minutula*, *A. minutuloides*, *A. subopaca* and *A. semilaevis*.

N. flavopicta (Kirby) **N** LONG: 03, ELV: 98, 02. A cleptoparasite of *Melitta* spp., almost certainly *M. leporina* at the two sites listed based on the host forage plants available.

N. fulvicornis F. **RDB3** ELV: 00, 04, where two of its known hosts were present, *Andrena bimaculata* and *A. tibialis*.

N. goodeniana (Kirby) LONG: 00, 01, 02, 03, SHERW: 97, 00, 02. A cleptoparasite of *Andrena nigroaenea* and *A. nitida*.

N. lathburiana (Kirby) **RDB3* (N?)** LONG: 00, SHERW: 97, 00, 02. A cleptoparasite of *Andrena cineraria*.

N. leucophthalma (Kirby) SHERW: 00, 03. The cleptoparasite of *Andrena clarkella* here.

N. marshamella (Kirby) ELV: 94, 96, 99, 00, 02, 03, SHERW: 97, 00, 02, WHINF: 03. A cleptoparasite of *Andrena scotica*.

N. panzeri Lepeletier ELV: 02, SHERW: 00, 02, WHINF: 03. A cleptoparasite of *Andrena fucata, A. helvola, A. lapponica* and *A. synadelpha*.

N. ruficornis (L.) LONG: 96, ELV: 99, 02, 03, SHERW: 00, 02. A cleptoparasite of *Andrena haemorrhoa*.

N. rufipes F. ELV: 96, 02, SHERW: 95, 04. A cleptoparasite of *Andrena denticulata* and *A. fuscipes*.

N. signata Jurine **RDB2** ELV: 00, 02. A cleptoparasite of *Andrena fulva* but considerably rarer then the host for reasons that are unclear and are seemingly not related to climate.

N. striata F. SHERW: 97, WHINF: 02, 03, 04. A cleptoparasite of *Andrena wilkella*. Its apparent absence from Longleat and Elveden is noteworthy, as is its abundance at Whinfell, which is far north of the other sites.

Osmia bicolor (Schrank) **N, Calc** LONG: 98, 00, ELV: 94, 96, 99, 00, 02, 03. Nests in empty snail shells in sparse turf. Foraged mainly on *Lotus corniculatus* at these two sites.

O. caerulescens (L.) LONG: 96, 01, ELV: 99, 02, 04, WHINF: 04. Nests in dead wood and cavities in walls. Foraged heavily on *Lotus* at these three sites.

O. leaiana (Kirby) LONG: 01, ELV: 98, 99, 00, 01, 03, SHERW: 01. Nests in dead wood and forages on Asteraceae, especially *Cirsium* and *Centaurea*.

O. rufa (L.) ELV: 99, 02, 03, SHERW: 97. Nests in dead wood and walls, including some of the lodges, and forages on a wide variety of spring flowers.

Panurgus calcaratus (Scopoli) LONG: 03. A ground-nesting bee that forages on Asteraceae such as *Hypochoeris* and *Leontodon*. The Longleat record came from restored heathland.

Sphecodes crassus Thomson **N* (no status)** LONG: 95, 97, 00, ELV: 94, 95, 02, 04. *Sphecodes* species are cleptoparsites of ground-nesting solitary bees, typically *Lasioglossum* and *Halictus*, plus a few *Andrena*. The hosts of this species include *Lasioglossum parvulum* (the coincidence of the two was fairly strong at Centerparcs, but not in places sich as Warwickshire where another host is evidently used).

S. ephippius (L.) LONG: 95, 96, 97, ELV: 94, 95, 96, 98, 99, 00, 02, 03, 04, SHERW: 96, 97, 98, 99, 00, 04, WHINF: 04. A cleptoparasite of *Halictus tumulorum* and *Lasioglossum leucozonium*.

S. ferruginatus Hagens **N** LONG: 95, WHINF: 02. Precise host(s) in Britain uncertain but possibly including *Lasioglossum fratellum* which was numerous at both locations alongside the *Sphecodes*.

S. geoffrellus (Kirby) LONG: 95, 96, 97, 01, 03, 04, ELV: 94, 95, 96, 98, 99, 02, 03, 04, SHERW: 95, 97, 00, WHINF: 04. A cleptoparasite of *Lasioglossum leucopum*, *L. morio* and others.

S. gibbus (L.) LONG: 95, 97, ELV: 95, 96, 98, SHERW: 95, 97, WHINF: 03, 04. A cleptoparasite of *Halictus rubicundus*.

S. hyalinatus Hagens LONG: 95, WHINF: 03, 04. A cleptoparasite of *Lasioglossum fratellum* and *L. fulvicorne* (possibly sharing these species with *S. ferruginatus*, alongside which it frequently occurs).

S. longulus Hagens **RDB3** ELV: 94, 95, 99, 04. Primarily a cleptoparasite of *Lasioglossum minutissimum*.

S. monilicornis (Kirby) LONG: 03, 04, ELV: 94, 95, 96, 99, 02, 03, 04, SHERW: 97, 00, WHINF: 02, 04. A cleptoparasite of *Lasioglossum albipes*, *L. calceatum* and possibly others.

S. niger Hagens **RDB3* (N)** ELV: 04. A cleptoparasite of *Lasioglossum morio*. Its late discovery at Elveden corresponds with a marked expansion of its range nationally in recent years.

S. pellucidus Smith, F. ELV: 94, 99, 03, 04, SHERW: 97, 00. A cleptoparasite of *Andrena barbilabris*.

S. puncticeps Thomson LONG: 95, ELV: 96, SHERW: 97, 98, 99, 01. A cleptoparasite of *Lasioglossum villosulum* and possibly others like *L. brevicorne*.

S. reticulatus Thomson **N** ELV: 95, 96, 98, 99, 02, 04, SHERW: 01. Another cleptoparasite of *Andrena barbilabris* and possibly also *A. dorsata* at Elveden (based on anecdotal observations).

SHORT COMMUNICATION

A record of *Afrephialtes cicatricosus* (Ratzeburg) (Hymenoptera: Ichneumonidae) from South Devon. – In a recent article, Shaw (2006) updated and extended the knowledge of the Pimplinae and Poemeniinae from the Royal Entomological Society (RES) key of Fitton *et al.* (1988). While some species in the RES key were found to be more widespread than supposed, reference was made to it being a matter of concern that for a few species, including *A. cicatricosus*, no recent records had been forthcoming.

I would therefore like to place on record that on 21.viii.1992 I captured a ♀ *A. cicatricosus* flying amongst bushes of *Salix caprea* in a then unmanaged marshy area at Newton Abbot, Devon (SX 8672). Interestingly, Fitton *et al.* state that the then three records of this species were from the adjacent county of Dorset and that it had been reared from the sesliid moth *Synanthedon formicaeformis* (Esper) – which feeds in Salix wood. I have not seen further examples of *A. cicatricosus* on subsequent field trips to this now somewhat managed area. – A. A. ALLEN, 20, Kingsdown Crescent, Dawlish, Devon.

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CONOCEPHALUS DORSALIS (LATREILLE) (ORTHOPTERA: TETTIGONIIDAE) IN MERSEYSIDE AND LANCASHIRE

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Abstract

Conocephalus dorsalis (Short-winged Conehead) was discovered at two Sefton Coast, Merseyside sites in 2002 and 2005 and at Warton Marsh on Morecambe Bay, Lancashire in 2005. These are new records for VC59 (South Lancashire) and VC60 (West Lancashire). This paper reports the circumstances of the discoveries and results of survey work in 2005.

Introduction

Conocephalus dorsalis (Latreille), the Short-winged Conehead, is a small cryptically-coloured bush-cricket, normally found in wet places, such as coastal salt-marshes and inland bogs and reed-beds (Marshall & Haes, 1990). Its British distribution is primarily southern and eastern, the recent northern limit being Anglesey in the west and the Humber Estuary in the east, though the insect is certainly spreading in some southern areas, more than half its known sites having been discovered since 1970 (Haes & Harding, 1997). Marshall & Haes (1990) comment that there are no records from the many suitable-looking coastal habitats in north-west England.

This article describes the discovery of *C. dorsalis* on the Sefton Coast, Merseyside (VC59) and at Warton, near Carnforth, Lancashire (VC60) and subsequent survey work.

Discovery

While conducting a vegetation survey at Marshside, Southport on 10 September 2002, P.S. Gateley photographed but did not identify *C. dorsalis* in Sea Club-rush (*Bolboschoenus maritimus*) at SD352205. Two years later, in the summer of 2004, S. Palmer and N. Hunt independently recorded the same species close to Gateley's locality, the latter drawing PHS's attention to its presence. PHS located and photographed two males and a female of *C. dorsalis* on 18 September 2004 near the sea-wall at Marshside.

This intertidal site, owned by Sefton Metropolitan Borough Council, has recently been leased by the RSPB as an extension to their Marshside Nature Reserve.

On 30 July 2005, C. Felton reported finding five large nymphs of *C. dorsalis* on salt-marsh at Birkdale Green Beach (SD315158), about 6 km south-west of the Marshside locality.

Using a Batbox 111 bat-detector from Stag Electronics set at 40 kHz, JMN noted the distinctive stridulation of *C. dorsalis* on 21 September 2005 in Sea Rush (*Juncus maritimus*) at SD473736 on Warton Saltmarsh, Morecambe Bay, Lancashire.

2005 Surveys

Methods

Searches for *C. dorsalis* were carried out at Marshside and Birkdale Green Beach on five occasions each between 5 August and 3 October 2005 and on Warton Saltmarsh for *C. dorsalis* on 21–22 September 2005.

Coneheads were located by walking very slowly (less than 0.5 km/h) through upper salt-marsh vegetation looking for any movement. Two males were found at Marshside on 19 September with the help of JMN's bat-detector and this technique was also used at Warton. Where possible, the insects were sexed and, in Merseyside, 10-figure grid references were determined using a Global Positioning System so that locations could be entered into the Sefton Coast Geographical Information System.

Results and Discussion

On the Sefton Coast, 102 adult and two final-instar nymphs of *C. dorsalis* were found, 64 at Marshside and 40 on Birkdale Green Beach (Table 1); by early October, numbers were much reduced. Apart from a single female of the long-winged form *burri* Ebner at Marshside, all were of the typical brachypterous type. Most sightings here were close to Gateley's original locality but some were found up to 500 m southwest and 500 m northeast of this site (SD349201–358210). Finds on the Green Beach, were made over a linear distance of 1.75 km, from SD319162 to SD309149. Males were occasionally seen stridulating at Marshside but this could not be heard without the aid of a bat-detector. Acoustic monitoring on 19 September at Marshside suggested that more male *C. dorsalis* were present than could be observed visually and showed that stridulation continued late into the afternoon, even in cloudy, cool and breezy conditions.

At Warton Marsh, one stridulating male was detected on 21 September and three the following day, while a single female was observed and photographed on 22 September.

The Sefton Coast finds were almost all made in dense Sea Club-rush up to 1 m tall. At Marshside, these stands have been mapped as the National Vegetation Classification's S21b (*Bulboschoenus* (*Scirpus*) *maritimus* swamp, *Atriplex prostrata* sub-community), while at Birkdale the plant community is S21c (*Bulboschoenus* (*Scirpus*) *maritimus* swamp, *Agrostis stolonifera* sub-community) (Gateley & Michell, 2002). At Warton, the vegetation consists of scattered, dense patches of Sea Rush in short, heavily-grazed grassland and probably equates to SM18 (*Juncus maritimus*

Table 1. Visual and bat-detector records of *Conocephalus dorsalis* at Marshside, Birkdale and Warton in 2005.

	Marshside (5 visits)	Birkdale Green Beach (5 visits)	Warton Marsh (2 visits)
Males	28	15	
Females	30	18	1
Unsexed	2	7	
Nymphs	2		
Males found by bat-detector	2		4
Total	64	40	5

salt-marsh). Such salt-marsh vegetation is occasionally inundated by tidal water. Thus, spring tides reaching 10.4 m ordnance datum in September 2005 caused extensive flooding at the Green Beach and Marshside. Evidently, the conehead populations are able to survive these exceptionally high tides.

It is interesting to speculate on the origin of these *C. dorsalis* populations. While the upper salt-marsh at Warton was formed between about 1862 and 1888 (Grey & Scott, 1987), the Sefton Coast habitat is no more than 10–15 years old (personal observations) so the insect must have arrived here recently. The distance from Anglesey to the Sefton Coast sites is about 75 km, while Warton Marsh is a further 55 km to the north of Marshside. These are long distances for a generally flightless orthopteran. However, Warne & Hartley (1975) consider the possible dispersion in sea-borne flotsam of *C. dorsalis* eggs, which can survive several months in sea-water. Influxes by flight of the long-winged form *burri* cannot be ruled out, especially in warmer summers when such forms are more frequent (Marshall & Haes, 1990).

In view of the ease with which this species is overlooked, it seems likely that careful searches, especially with a bat-detector, will discover *C. dorsalis* on other north-western salt-marshes, such as those on the Dee and other parts of the Ribble and Morecambe Bay.

Acknowledgements

The authors are grateful to Steven Judd of Liverpool Museum and Peter Gateley for information. Mike Wilcox and two referees kindly made constructive comments on a draft of the manuscript.

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SHORT COMMUNICATION

***Volucella inanis* (L.) (Diptera: Syrphidae) in Perry Woods, Kent.** – A specimen of this large hoverfly was observed visiting flowers of *Eucryphia* in our garden, in Selling, east Kent on 31.viii.2006. This is the first time the species has been recorded in the garden. The main reason for observing it was the appearance of several noisy hornets which along with numerous *Bombus* spp. were attracted to the tree's large white flowers. Morris and Ball (*BJENH* **16**: 221–227) report on the recent expansion in range of this hoverfly in England (up to 1999, thereafter the species shows a possible decline) and speculate on whether its success is due in any way to the changing fortunes of the hornet. The sudden appearance of both species may be significant. – J. S. Badmin, Coppice Place, Selling, Kent ME13 9RP.

STRATIFICATION AND PHENOLOGY OF A WOODLAND HETEROPTERA ASSEMBLAGE IN SOUTHERN BRITAIN

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Abstract

The Heteroptera collected by Malaise traps placed at ground level and in the canopy of a birch woodland are presented, and the assemblage compared to that obtained in the same woodland by a combination of beating-bag and D-Vac samples. The two methodologies produced a broadly similar result, and revealed that the assemblage was highly stratified between tree dwelling and epigeal species. The phenology of the assemblage showed a peak in autumn, unlike the groups previously studied in this woodland.

Introduction

The Heteroptera are a relatively small group, but they exhibit a wide range of feeding strategies (Southwood & Leston, 1959). Most are found on plants, although there are some epigeal species, and they are known to respond to changes in vegetation structure as well as composition (Dolling, 1991).

In 1991, as part of a study of canopy insects, Malaise traps were placed in an area of birch woodland (Hollier & Belshaw, 1993). The adult Heteroptera were identified, providing information about the phenology and stratification of the assemblage. Since this woodland had been sampled for Heteroptera some 14 years earlier using a combination of beating-bag and D-vac suction sampling to collect both canopy and field layer or ground-dwelling insects (Southwood *et al.*, 1979), the Malaise trap data also allow comparison of the two sampling regimes and possible successional changes in the assemblage.

Methods

The study was carried out at Silwood Park, Sunninghill, Berkshire, during the summer of 1991. The site was an area of 70 year old birch woodland that enclosed a number of older oak and beech trees which had formed part of the park. The woodland edge, where it abutted grassland, had a band of bracken but the interior of the woodland had a very sparse vegetation. The site has been described in some detail in Southwood *et al.* (1979).

Two pairs of Malaise traps were set up near the edge of this woodland, one pair on the ground, the other pair on the wooden platforms at the top of the 6m high scaffolding towers used by Southwood *et al.* (1979). The traps on top of the towers were in the lower canopy of the birch, and one of the traps projected above the canopy of a storm-damaged beech. The traps on the ground were some 5 m to the side of each tower; all traps had the same orientation and an effective entrance height of about 1m. The traps were operated from May to September inclusive, the captured material being removed monthly. Sampling in 1977 was a combination of beating-bag and D-vac sampling (Southwood *et al.*, 1979) which collected insects in the canopy, field and ground layers; these data are compared with the Malaise trap catches.

Results and discussion

Assemblage composition

A total of 4445 adult Heteroptera, of 40 species, were identified from the Malaise traps (see Table 1). Perhaps unsurprisingly, the assemblage was dominated by the eight species associated with birch in Britain (Nau, 1992), all of which were present in the samples. Birch-associated species accounted for 4197 (94%) of the individuals and seven of the ten most abundant species (see Table 2). The very low abundance of 'tourists' (species primarily associated with other habitats or host plants) was notable given that Malaise traps are interception traps; this phenomenon was also noted for the Auchenorrhyncha however (Hollier, 2004).

Several of the species abundant in the earlier sampling were rare in the Malaise trap samples (see Table 2); given that these were the epigeal *Stygnocoris sabulosus* (Schilling) and *Drymus sylvaticus* (Fabr.), and the tiny predatory *Myrmedobia distinguenda* Reuter, the females of which are micropterous, this is clearly the consequence of a systematic sampling bias.

The abundance of *Psallus varians* (Herrich-Schaeffer) and *P. perrisi* (Mulsant & Rey), normally associated with oak, in both sets of samples was unexpected, especially given the otherwise low number of 'tourists'. It is possible that these species are able to use beech as an alternative host plant.

A single species, *Kleidocerys resedae* (Panzer), accounted for 3660 (82%) of the Heteroptera captured in the Malaise traps. This species feeds on the seeds developing in birch and alder catkins and over-winters as an adult. Hibernation is generally away from the host plant and *K. resedae* is consequently often abundant on other plants, for example it was the third most abundant species in a fogging study of oak trees (Dolling, 1985). The dominance of *K. resedae* means that the equitability of the assemblages is low, particularly for the ground samples. The overall pattern is similar to the D-vac and beating-bag samples, as Fig. 1 shows.

Stratification

There was little difference in species abundance between the canopy and ground traps, except that *Monalocoris filicis* (L.), a species associated with bracken in the field layer, was more abundant in the ground traps. Given the paucity of the field layer, especially deeper in the woodland, this is not particularly surprising, although several grass-feeding species of Auchenorrhyncha were taken in the ground level traps. As noted above however, there is a very large difference between the two sampling methods, and the assemblage is strongly stratified between arboreal and epigeal species. The canopy samples were significantly more diverse than the ground samples (canopy and ground Shannon Indices 1.37 and 0.60, respectively). The D-Vac and beating-bag samples were significantly more diverse than either canopy or the combined Malaise trap samples (D-vac and beating Shannon Index 1.84, combined Malaise samples Shannon Index 0.89).

Phenology

The phenology of the assemblage was similar for ground and canopy samples, as Fig. 2 shows. The increase towards the end of the sampling season was very different from the pattern seen in both Neuroptera and Auchenorrhyncha (Hollier & Belshaw,

Table 1. The number of each species captured in the canopy and ground level Malaise traps in birch woodland at Silwood Park, Ascot, in 1991.

	Canopy		Ground	
	East	West	East	West
Acanthosomatidae				
Elasmostethus interstinctus (L.)	64	76	93	36
Elasmucha grisea (L.)	4	1	5	7
Anthocoridae				
Anthocoris confusus Reuter	1	5	10	8
Anthocoris nemoralis (Fabr.)	10	25	18	12
Anthocoris nemorum (L.)			1	
Orius niger (Wolff)	1	1		3
Lygaeidae				
Drymus brunneus (Sahlberg)				1
Kleidocerys resedae (Panzer)	332	628	1458	1242
Peritrechus geniculatus (Hahn)				1
Scolopstethus thomsoni Reuter				1
Microphysidae				
Loricula elegantula (Baerensprung)	1	1	1	1
Myrmedobia coleoptrata (Fallén)			1	
Miridae				
Blepharidopterus angulatus (Fallén)	44	27	14	7
Campyloneura virgula (Herrich-Schaeffer)	1	8		4
Deraeocoris lutescens (Schilling)	1	1		
Dryophilocoris flavoquadrimaculatus (De Geer)			1	1
Harpocera thoracica (Fallén)		1	1	
Lopus decolor (Fallén)	1			
Lygocoris contaminatus (Fallén)	20	27	23	18
Miris striatus (L.)				2
Monalocoris filicis (L.)	5	2	8	2
Orthotylus marginalis Reuter	1			
Pantilius tunicatus (Fabr.)	3	9	1	1
Phylus melanocephalus (L.)	1			
Phytocoris dimidiatus Kirschbaum		4		1
Phytocoris longipennis Flor	1			1
Phytocoris tiliae (Fabr.)	7	7	1	1
Plagiognathus arbustorum (Fabr.)				1
Plagiognathus chrysanthemi (Wolff)	1			
Psallus ambiguus (Fallén)				2
Psallus betuleti (Fallén)	13	2	4	
Psallus falleni Reuter	22	12	3	1
Psallus haematodes (Gmelin)			1	
Psallus perrisi (Mulsant & Rey)		14	15	20
Psallus quercus (Kirschbaum)	2			
Psallus varians (Herrich-Schaeffer)	3	12		
Rhabdomiris striatellus (Fabr.)	3		1	
Salicarus roseri (Herrich-Schaeffer)		1		
Pentatomidae				
Eurydema oleracea (L.)				2
Pentatoma rufipes (L.)		1		2
Number of individuals	542	865	1660	1378
Number of species	24	22	20	26

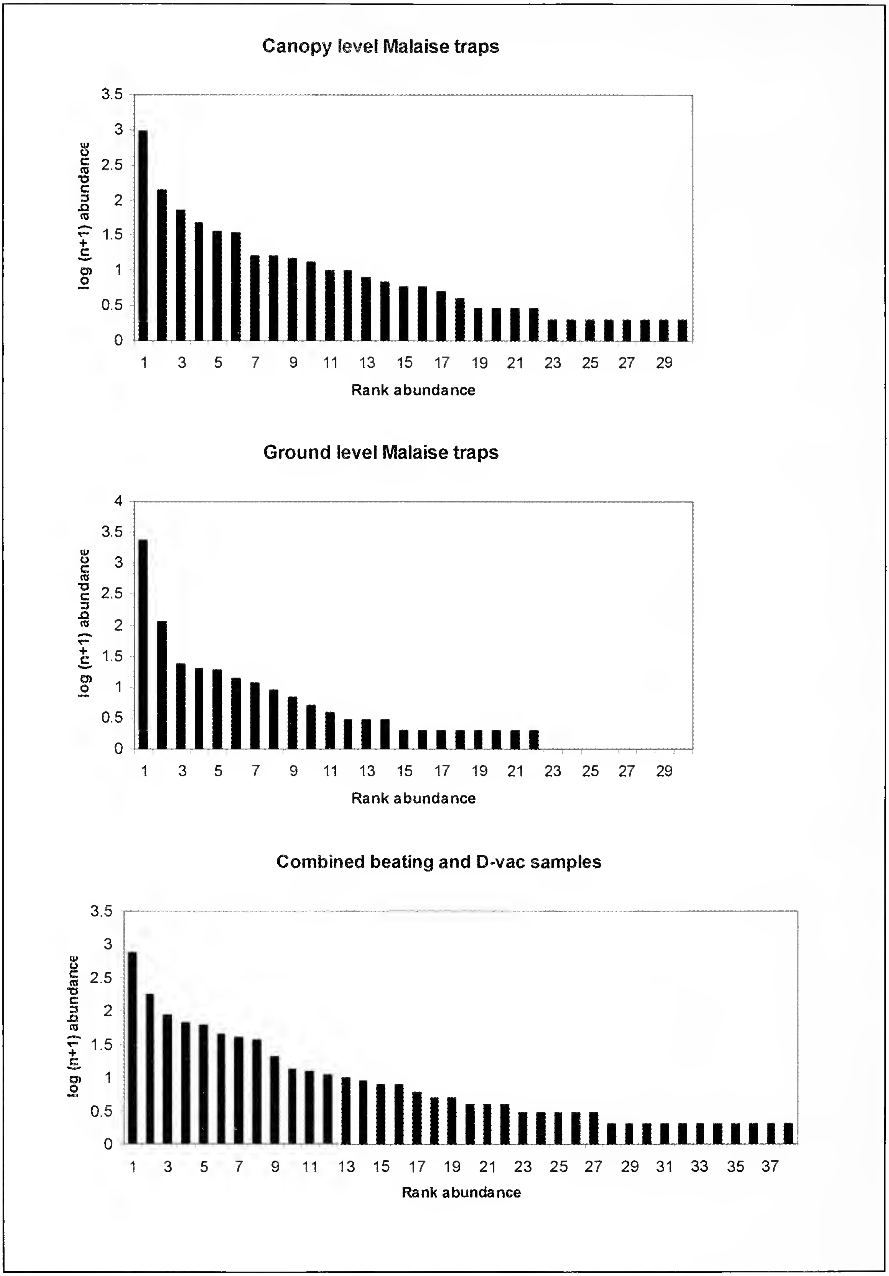

Figure 1. Rank abundance (log (n + 1)) of species captured in canopy and ground level Malaise traps in birch woodland at Silwood Park in 1991, and in combined beating and D-Vac samples in the same woodland in 1977.

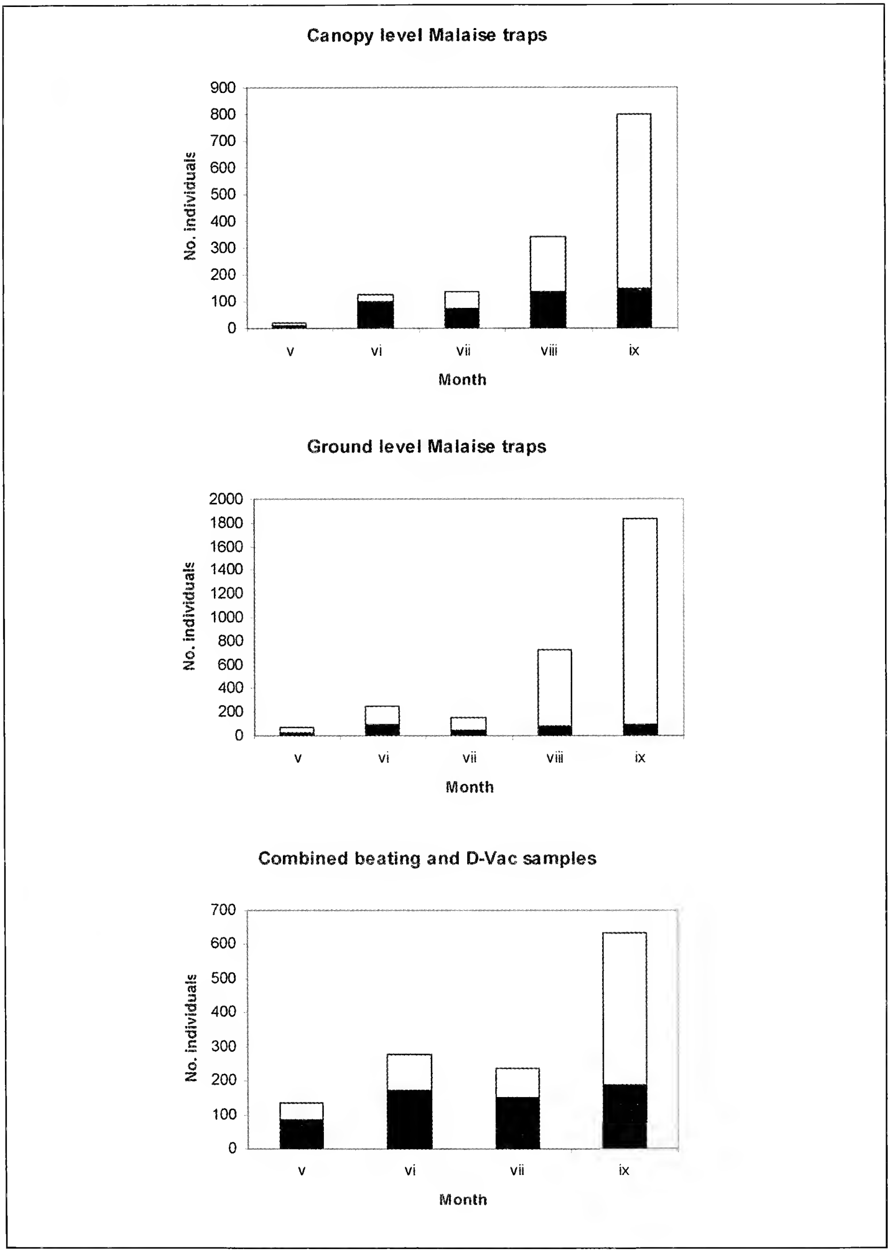

Figure 2. Number of individuals of *Kleidocerys resedae* (open bars) and other species (solid bars) captured in each month in canopy and ground level Malaise traps in birch woodland at Silwood Park in 1991, and in combined beating and D-Vac samples in the same woodland in 1977.

Table 2. Species in rank order of abundance in samples (nomenclature follows Aukema (2005)).

Rank	Canopy Malaise traps	Ground Malaise traps	Beating & D-vac samples
1	*Kleidocerys resedae*	*Kleidocerys resedae*	*Kleidocerys resedae*
2	*Elasmostethus interstinctus*	*Elasmostethus interstinctus*	*Stygnocoris sabulosus*
3	*Lygocoris contaminatus*	*Lygocoris contaminatus*	*Lygocoris contaminatus*
4	*Blepharidopterus angulatus*	*Anthocoris nemoralis*	*Myrmedobia distinguenda*
5	*Anthocoris nemoralis*	*Blepharidopterus angulatus*	*Blepharidopterus angulatus*
6	*Psallus falleni*	*Psallus perrisi*	*Elasmostethus interstinctus*
7	*Psallus betuleti*	*Anthocoris confusus*	*Monalocoris filicis*
8	*Psallus varians*	*Elasmucha grisea*	*Drymus brunneus*
9	*Phytocoris tiliae*	*Monalocoris filicis*	*Psallus varians*
10	*Pantilius tunicatus*	*Campyloneura virgula*	*Anthocoris confusus*

1993; Hollier, 2004), where peaks occurred earlier in the season, followed by a tailing off in numbers. Given the dominance in the assemblage of *K. resedae*, which is known to disperse in large numbers in autumn, this might be regarded as another artefact of the sampling method. As the figure shows however, the pattern is the same in the D-vac and beating-bag samples. Even after *K. resedae* is excluded, the phenology remains distinct from that observed for the other groups, possibly because of the mix of feeding strategies exhibited by the Heteroptera. Unlike the Auchenorrhyncha, which feed primarily on growing buds, leaves and shoots, or the Neuroptera which prey primarily on soft-bodied invertebrates feeding in this way, the Heteroptera includes partially predacious species as well as seed feeders and more generalist predators, and are thus not so closely tied to the period of leaf growth.

Conclusions

The Heteroptera captured belonged to a number of feeding guilds (Moran & Southwood, 1982). The herbivores were overwhelmingly stenophagous on the plants dominating the area sampled, a situation similar to that shown by Brown and Hyman (1986) for phytophagous Coleoptera. The predators were more generalist, although species such as *Anthocoris confusus* Reuter and *Myrmedobia distinguenda* are strongly associated with trees. The assemblage was highly stratified, with an epigeal component as well as *Monalocoris filicis* from the field layer and the tree dwelling species. The assemblage had very few ‘tourists’, notwithstanding the fact that interception traps were used, which suggests that the Heteroptera are strongly habitat specific.

Acknowledgements

The author is grateful to Dr. Robert Belshaw for sharing the task of running the traps and for many useful discussions, and to Professor Valerie Brown who supervised the work at Imperial College. Special thanks are due to the late Professor Southwood, for the use of his data and the inspiration of his work on the Heteroptera and succession.

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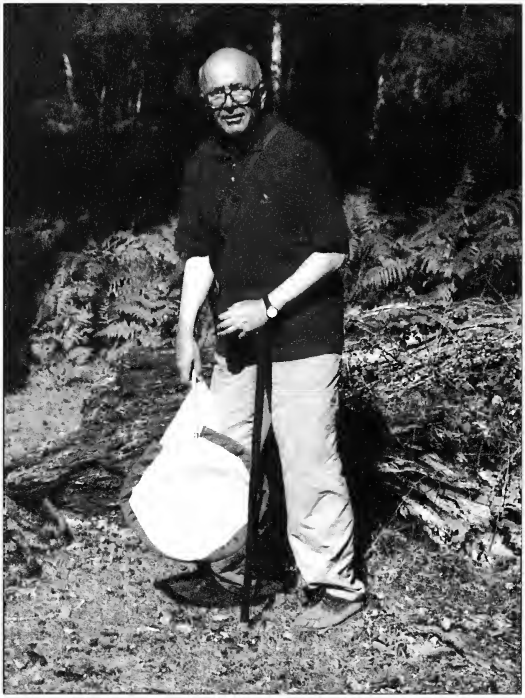
SHORT COMMUNICATION

Further records of *Brachycarinus tigrinus* (Schilling) (Hemiptera: Rhopalidae).– This distinctive and pretty bug was described new to Britain in 2003 from two specimens found in Battersea Park, central London (Jones, R.A. 2004. *British Journal of Entomology and Natural History* **17**: 137–141). It later appeared in Essex (Harvey, P. & Bowdrey, J. 2006. *Essex Naturalist*, *New series* **23**: 39–40). Therefore readers will not be surprised to learn that it has started to appear at several other sites in the Thames Estuary area. I swept one specimen at Swanscombe Marshes, W. Kent, TQ605765, on 21.vi.2006, at a field meeting organized by Buglife, the Invertebrate Conservation Trust as part of the "All of a buzz in the Thames Gateway" study of brownfield sites. Several specimens were swept by myself and Mark Telfer on a visit to Thames Barrier Park East, S. Essex, TQ413800, on 13.ix.2006. I also swept another rhopalid bug, *Liorhyssus hyalinus* (Fab.). Later that same day I swept a specimen of *Brachycarinus* at Southfields, Belvedere, W. Kent, TQ501800; and another was found in Woolwich, W. Kent, TQ412785. This last specimen was found on the outside of the car window as we were driving back through south London. It must have just landed, shortly before we spotted it, because a few minutes earlier we had been driving at 40–50 mph and the bug would have been unable to land at that speed. The traffic slowed almost to a standstill in Woolwich. Luckily I was able to wind the window down slightly, grab the bug in my fingers and drop it into a water bottle passed to me by Mark.–Richard A. Jones, 135 Friern Road, East Dulwich, London SE22 0AZ (bugmanjones@hotmail.com)

OBITUARY

David Michael Appleton
1944–2006



David was one of those people who seem to have a genetic predisposition to become an entomologist. He was already hooked whilst at infant school, without active encouragement from anyone. He was self-taught, starting by being a serial borrower of South's *The Moths of the British Isles* from the library. By the time he had finished secondary modern education and taken a clerical job in the Civil Service at the age of sixteen, he had already reared a number of moths from eggs, had a small collection of Lepidoptera, and was cognisant of sugaring and pupa digging. Having no moth trap, he always checked shop-windows and frequently recorded interesting species in this way. In his early 20s he met other local naturalists including two of us, George Else and myself, who shared his interest. At that point he already had a growing interest in beetles, which were to be his main passion. In those days we spent Saturdays in the field, where David was held in awe as the ultimate insect-hunter. He had a very keen eye, regularly searched tree trunks and found moths. In spring he counted the Early Greys, *Xylocampa areola* (Esper) and Engraileds, *Ectropis bistortata* (Goeze) on the Scots Pine trunks in Botley Wood, Hampshire, our local favourite site. He seemed immune from discouragement. If his quarry was there (and he always started with the premise that it *was* there) then he would find it! He put his myopia to good use by lifting his glasses and holding some minute creature very close to his eye. It also enabled him to set and mount specimens to the very highest of

standards, and to write labels that were impeccable but tiny. Being so short-sighted had its down-side though. On one mv trip to an area formerly worked for gravel, David wandered off looking for carabid beetles on the paths with his torch – invariably his bicycle front lamp in those days. He reappeared a while later with bright yellow-brown silt-stains all over his clothes, his glasses and the lens of his torch. He had seen a sign and gone closer to read it. It said DANGER – QUICKSANDS. Another time, he had been grubbing on the Isle of Wight, working his way inch by inch on all fours along the undercliff above a beach, oblivious to anything more than a few inches away. Then he came across a pair of bare feet. Scanning slowly upwards, he found them to be attached to bare legs and thus to a man who was . . . .entirely naked. It transpired that he had been working above a naturist beach, and the man had mistaken him for a Peeping Tom. Once the matter had been resolved, he showed considerable interest in what David was doing.

He lived alone all his life in rented rooms of quite monastic austerity. He was essentially a shy person, anxious with strangers but still needing friends. It required the context of work or entomology to break the ice, but friends, once made, were never discarded. Especially in the early days it was impossible to deal with at least the smaller beetles without some help, and once contact was made, he formed friendships which took him out into the field with many of our coleopterist brethren. He knew the New Forest – at least the preferred areas in the southern part – like the back of his hand, and had an almost legendary nose for a *Cossus*-tree. It was on one such trip in late autumn with the late Eric Gardener and others that Eric made an incautious investigation of a fragment of hornet's nest, believed to have been dragged out by badgers and to be bereft of its legitimate residents. Unfortunately this proved not to be the case, and David related the spectacle of Eric in full retreat pursued by hornets, several of which got their man, particularly his bald pate! David never had a car, nor even drove, but quartered his beloved Hampshire with a combination of bicycle, bus and train. Sometimes he would return labouring under a heavy bag of flood debris, wood mould or sievings. Pamber, Harewood, Alice Holt and other well-know sites were all on his circuit, but he loved investigating little known places, and particularly in passing on to me records from strange-sounding localities such as Bedlam Bottom, Land of Nod, Nob's Crook, Oliver's Battery, Shide Pit and World's End. Trips with friends were highlights, but the great bulk of his fieldwork was done entirely alone. The need to go out and find things possessed him. The travelling could be quite punishing. To accompany him to Luccombe Cliffs on the Isle of Wight involved catching a train at about 7 a.m., followed by a ferry, another train, a bus and then a long steep walk, arriving at around 10 a.m. Thus nearly more time was spent travelling than on fieldwork. He made some outstanding discoveries of which he was justifiably proud, including Coleoptera species new to Britain (*Hylis cariniceps* (Reitter), *Axinotarsus marginalis* (Laporte de Castelnau) and *Sphinginus lobatus* (Olivier)). Perhaps he was most proud of finding a breeding population of the beautiful click-beetle *Anostirus castaneus* (L.) at Luccombe Cliffs. He wrote many notes to the entomological journals about these, and an extensive bibliography will appear in the *Entomologists' Monthly Magazine* (Dickson & Else, 2007). During these productive years he contributed to a number of local insect surveys.

In the 1980s he disposed of his collection and entomological books. Many of his Coleoptera and Hemiptera Heteroptera were purchased by Hereford Museum. I think he found working on tiny taxa unsustainable when there were so few people with whom he could share his interest. For a few years he travelled, made an attempt to return to art (of which he had a life long interest) and even took a brief interest in old entomological books (mainly British butterflies). He had always been interested

in other insects and he dabbled for a while, first with het bugs, then tortricoid moths, then hoverflies and the larger Brachycera And although he never truly espoused the aculeate Hymenoptera, he would collect these and pass them to George. Thus many of them are now in the Natural History Museum, London. In the 1990s he was overtaken by Parkinson's Disease and suffered uncountable falls. He persevered and put his breadth of knowledge to work on an entomological survey of a local nature reserve. But it was risky. Inevitably he had falls in remote places. In the worst of these he was on the ground overnight. Rescue services had to cut a padlock and drive through a wood to get to him, by which time he was delirious. In August 2006 he found the lygaeid bug *Aphanus rolandri* (L.) on Southampton Common. The following month he was found dead there. Perhaps he had gone back to see what else he could find.

RICHARD DICKSON

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BOOK REVIEW

Moths of Europe Volume 1, by Patrice Leraut (2006). 387pp. N.A.P. Editions. ISBN 2-913688-07-1. Price 59€.

The author is a well-known French taxonomist who works at the Natural History Museum in Paris and has published definitive checklists of the French Lepidoptera in 1980 and 1997. We can therefore be sure that his information is up-to-date and accurate, and can respect his views on difficult taxonomic problems, even where other taxonomists may disagree.

The book is an English edition and the translation from French is good. It covers the following families in the following order: Saturniidae (11 species), Lemoniidae (7), Brahmaeidae (1), Bombycidae (1), Endromidae (1), Notodontidae (54, including 8 Thaumetopoeinae), Lasiocampidae (58), Drepanidae (21), Lymantriidae (34), Axiidae (5), Limacodidae (5), Somabrachyidae (6), Heterogynidae (9), Thyrididae (1), Castniidae (1), Cossidae (46), Sphingidae (38), Hepialidae (22) & Arctiidae (119). Leraut says in the introduction that these are the large moths minus the noctuids and the geometers, which are dealt with in *a* (sic) following work, but there will be three volumes in all according to the *napeditions.com* website. The Psychidae are not included in Volume 1 despite what it says in at least one English bookdealer's catalogue. It remains to be seen whether these and the Sesiidae and the Zygaenidae will appear in later volumes.

The families dealt with in Volume 1 are already largely covered on a European basis in other works such as de Freina & Witt (1987), and Rougeot & Viette (1978), both of which have somewhat better life-size colour photographs, but the former is expensive, in German, and too big to carry in the field and the latter is in French, presumably out of print and in particular does not cover the Arctiidae or Lymantriidae. I will buy Leraut's Volume 1 to carry in the field, but am more excited at the thought of buying Volumes 2 and 3 in the future, as there is at present no single book illustrating all the European Noctuidae or Geometridae. The three

volumes together may do as much to stimulate entomology in continental Europe as Skinner's (1984) 'Identification Guide to Moths of the British Isles' did for Great Britain and Ireland. The *napeditions.com* website gives no indication as to when these later volumes will appear. Let us hope that they do.

Leraut's book covers 'Europe and neighbouring regions, in particular North Africa and the Middle East'. All of the known species in Europe are illustrated, but no such claim is made for 'the neighbouring regions', and as far as I can see the exact area covered is not defined anywhere.

The overall layout of the book and the small page size (approx 13cm × 20 cm) remind me of the classic Peterson Field Guide to the Birds of Britain & Europe, which was easy to use and small enough to be carried conveniently in the field – as is this. The colour plates and their captions are gathered together as pages 129–288 of the 387 numbered pages. The fact that these 'plate' pages are numbered in the same manner and sequence as the main text makes it easy to find one's way around the book. If opened in the colour plate section the illustrations are on the right (recto) page. The left (verso) page has the scientific names displayed boldly, the English names (many specially invented for this edition by Robin Howard), the wingspan, a comment on the scarcity and/or distribution, and the page number reference to the main text. The layout of this information is excellent. You know exactly where to look. The presence of the scarcity/ distribution information makes it easier to pick out the most likely 'match' when there are several similar species. The images have sufficient resolution, but are slightly smaller than I would like (and with no direct indication of the actual magnification). Artificial shadows are added as though illuminated from the left, which to my eye gives a smudged appearance, but does not detract from the value of the image.

In the main text the descriptions of the eight families Saturniidae to Drepanidae and the three families from Sphingidae to Arctiidae start with a full page of comments on the family and drawings of the wing venation. For some unexplained reason, the 8 families Lymantriidae to Cossidae do not. Detailed text for species and subspecies consists of scientific, English and French names and information on the male, female, variations, closely related species, biology, flight-time, distribution and status and additional comments. Distribution maps are set into the text, but the maps do not cover the full area under consideration. They cut off east of Yugoslavia. There is a reference to the plate number but not to the page number of the plate, which would have made locating the plate fractionally easier and avoided any possible confusion between plate numbers and page numbers. There are also some very useful text illustrations of wing patterns in the style used by Skinner, and some genitalia illustrations for difficult groups.

Three new species are described (*Cilix algirica*, *Heterogynis valdeblorensis* and *Heterogynis pravieli*) as well as five new subspecies and five new forms.

All but six of the species and two of the subspecies under consideration are illustrated, but the main text has detailed entries for only about 323 out of the 440 species and for only 17 subspecies (mainly those where Leraut has just revised the genus). The rest of the species and subspecies are usually referred to in the text somewhere, perhaps very briefly under 'closely related species'

The index is good. One can look up generic, specific or subspecific scientific names and be directed to the relevant *page* numbers for both text and plates. There is no index to the English names.

The book is well worth buying and the whole set of three volumes will be a must for anyone working in continental Europe.

NORMAN HALL

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THE MAITLAND EMMET BENHS RESEARCH FUND

In 2001 the family of the late Lt. Col. Maitland Emmet, a distinguished amateur microlepidopterist, made a generous donation to the Society's Research Fund in his memory As a result the Society has renamed its Research Fund the Maitland Emmet BENHS Research Fund. The Society is very grateful to the Emmet family for their generosity.

The Society invites applications for grants, from the Maitland Emmet Research Fund, to be awarded in December 2007. Awards are open to both members and non-members of the BENHS and will be made to support research on non-marine arthropods, with reference to the British fauna, and with preference given to insects, arachnids, myriapods and isopods. Grants will be given for:

(a) the assistance of fieldwork on non-marine arthropods with relevance to their conservation,

(b) work leading to the production of identification guides and distribution lists, but not the cost of publishing such items.

Travel to examine museum collections and to consult taxonomic specialists would be included. The work and travel is not limited to the British Isles but must have a demonstrable relevance to the British arthropod fauna. Individual grants are unlikely to exceed £500.

Preference will be given to work with a clear final objective (e.g., leading to publication or the production of a habitat management plan). Work on leaf miners and gall forming insects should be submitted to the Society's Professor Hering Memorial Research Fund.

Applicants should send seven copies, if possible, of their plan of work, the precise objectives, the amount for which an award is requested and a brief statement outlining their experience in this area of work, to **Dr J. Muggleton, 17 Chantry Road, Wilton, Salisbury, Wiltshire SP2 0LT**, as soon as possible and **not later than 30 September 2007**. Further information may be obtained from the same address (email: jmuggleton@aol.com).

THE PROFESSOR HERING MEMORIAL RESEARCH FUND

The British Entomological and Natural History Society announces that awards may be made from this Fund for the promotion of entomological research with particular emphasis on:

(a) leaf-miners
(b) Diptera, particularly Tephritidae and Agromyzidae
(c) Lepidoptera, particularly Microlepidoptera
(d) general entomology

in the above order of preference having regard to the suitability of applicants and the plan of work proposed.

Awards may be made to assist travelling and other expenses necessary for fieldwork, for the study of collections, for attendance at conferences, or, exceptionally, for the costs of publication of finished work. In total they are unlikely to exceed £1000 in the year 2007.

Applicants should send seven copies, if possible, of a statement of their qualifications, of their plan of work, and of the precise objectives and amount for which an award is sought, to **Dr J. Muggleton, 17 Chantry Road, Wilton, Salisbury, Wiltshire SP2 0LT** as soon as possible and **not later than 30 September 2007**.

Applications are also invited from persons wishing to borrow the Wild M3 Stereomicroscope and fibre optics illuminator bequeathed to the Fund by the late Edward Pelham-Clinton, 10th Duke of Newcastle. Loan of this equipment will be made for a period of up to six months in the first instance.

MEMBERS' EMAIL ADDRESSES

We would like to add email addresses to the Society's membership database. We hope this will speed our communications with you and reduce costs. If you have an email address please email to the Hon. Secretary (jmuggleton@aol.com) and put 'BENHS email' in the subject box. It would help us if you could also indicate whether you would be happy to receive Society notices etc. at this email address.

NEUROPTERA, MEGALOPTERA AND RAPHIDIOPTERA WEBSITE

A global bibliography of published papers and research documents on the Neuropterida including papers published on European species in the *British Journal of Entomology* may be found at the following website:

http://entowww.tamu.edu/research/neuropterida/neur_bibliography/bibhome.html

BRITISH JOURNAL OF ENTOMOLOGY AND NATURAL HISTORY
VOLUME 20, PART 1, MARCH 2007

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